# ENGINEERING CHANGE NOTICE



1. ECN 635438

Proj. ECN

| | | | |
|---|---|---|---|
| 2. ECN Category (mark one)<br>Supplemental []<br>Direct Revision [X]<br>Change ECN []<br>Temporary []<br>Standby []<br>Supersedure []<br>Cancel/Void [] | 3. Originator's Name, Organization, MSIN, and Telephone No.<br>Cheryl J. Benar, Data Assessment and Interpretation, R2-12, 372-1256 | 4. USQ Required?<br>[] Yes [X] No | 5. Date<br>02/20/97 |
| | 6. Project Title/No./Work Order No.<br>Tank 241-B-111 | 7. Bldg./Sys./Fac. No.<br>241-B-111 | 8. Approval Designator<br>N/A |
| | 9. Document Numbers Changed by this ECN (includes sheet no. and rev.)<br>WHC-SD-WM-ER-549, Rev. 0 | 10. Related ECN No(s).<br>N/A | 11. Related PO No.<br>N/A |

| 12a. Modification Work | 12b. Work Package No. | 12c. Modification Work Complete | 12d. Restored to Original Condition (Temp. or Standby ECN only) |
|---|---|---|---|
| [] Yes (fill out Blk. 12b)<br>[X] No (NA Blks. 12b, 12c, 12d) | N/A | N/A<br>Design Authority/Cog. Engineer Signature & Date | N/A<br>Design Authority/Cog. Engineer Signature & Date |

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

This ECN was generated in order to revise the document to the new format per Department of Energy performance agreements.

14a. Justification (mark one)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Criteria Change | [] | Design Improvement | [] | Environmental | [] | Facility Deactivation | [] |
| As-Found | [X] | Facilitate Const | [] | Const. Error/Omission | [] | Design Error/Omission | [] |

14b. Justification Details

This document was revised per Department of Energy performance agreements and direction from the Washington State Department of Ecology to revise 23 tank characterization reports (letter dated 7/6/95).

15. Distribution (include name, MSIN, and no. of copies)

See attached distribution.

RELEASE STAMP

DATE: MAR 17 1997

STA: 4

HANFORD RELEASE

ID: 2

A-7900-013-2 (05/96) GEF095

A-7900-013-1

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| ENGINEERING CHANGE NOTICE | Page 2 of 2 | 1. ECN (use no. from pg. 1) ECN-635438 |
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| 16. Design Verification Required | 17. Cost Impact | | | | 18. Schedule Impact (days) | |
|---|---|---|---|---|---|---|
| | ENGINEERING | | CONSTRUCTION | | | |
| [] Yes | Additional | [] $ | Additional | [] $ | Improvement | [] |
| [X] No | Savings | [] $ | Savings | [] $ | Delay | [] |

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

| | | | | | |
|---|---|---|---|---|---|
| SDD/DD | [] | Seismic/Stress Analysis | [] | Tank Calibration Manual | [] |
| Functional Design Criteria | [] | Stress/Design Report | [] | Health Physics Procedure | [] |
| Operating Specification | [] | Interface Control Drawing | [] | Spares Multiple Unit Listing | [] |
| Criticality Specification | [] | Calibration Procedure | [] | Test Procedures/Specification | [] |
| Conceptual Design Report | [] | Installation Procedure | [] | Component Index | [] |
| Equipment Spec. | [] | Maintenance Procedure | [] | ASME Coded Item | [] |
| Const. Spec. | [] | Engineering Procedure | [] | Human Factor Consideration | [] |
| Procurement Spec. | [] | Operating Instruction | [] | Computer Software | [] |
| Vendor Information | [] | Operating Procedure | [] | Electric Circuit Schedule | [] |
| OM Manual | [] | Operational Safety Requirement | [] | ICRS Procedure | [] |
| FSAR/SAR | [] | IEFD Drawing | [] | Process Control Manual/Plan | [] |
| Safety Equipment List | [] | Cell Arrangement Drawing | [] | Process Flow Chart | [] |
| Radiation Work Permit | [] | Essential Material Specification | [] | Purchase Requisition | [] |
| Environmental Impact Statement | [] | Fac. Proc. Samp. Schedule | [] | Tickler File | [] |
| Environmental Report | [] | Inspection Plan | [] | | [] |
| Environmental Permit | [] | Inventory Adjustment Request | [] | | [] |

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

| Document Number/Revision | Document Number/Revision | Document Number Revision |
|---|---|---|
| N/A | | |

21. Approvals

| | Signature | Date | | Signature | Date |
|---|---|---|---|---|---|
| Design Authority | | | Design Agent | | |
| Cog. Eng. C.J. Benar | Cheryl J. Benar | 3/13/97 | PE | | |
| Cog. Mgr. K.M. Hall | Kathleen M. Hall | 3/13/97 | QA | | |
| QA | | | Safety | | |
| Safety | | | Design | | |
| Environ. | | | Environ. | | |
| Other R.J. Cash | R.J. Cash | 3/14/97 | Other | | |
| N.W. Kirch | N W Kirch | 3-13-97 | | | |

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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# Tank Characterization Report for Single-Shell Tank 241-B-111

Cheryl J. Benar
Lockheed Martin Hanford Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: ECN-635438 UC: 2070
Org Code: 74620 Charge Code: N4G4C
B&R Code: EW 3120074 Total Pages: 183

Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-B-111, Tank B-111, B-111, B Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-B-111. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.



Release Approval 3/14/97 Date

DATE: HANFORD RELEASE
STA: 4 ID: 2
MAR 17 1997
Release Stamp

**Approved for Public Release**

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| RECORD OF REVISION | (1) Document Number HNF-SD-WM-ER-549 | Page 1 |
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(2) Title
Tank Characterization Report for Single-Shell Tank 241-B-111

CHANGE CONTROL RECORD

| (3) Revision | (4) Description of Change - Replace, Add, and Delete Pages | Authorized for Release (5) Cog. Engr. | (6) Cog. Mgr. Date |
|---|---|---|---|
| 0 | (7) Initially released 06/06/96 on EDT-616006. | C.J. Benar | J.G. Kristofzski |
| | | | |
| 1 RS | Incorporate per ECN-635438. | C.J. Benar<br>C.J. Benar 3/13/97 | K.M. Hall [signature] 3/13/97 |
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HNF-SD-WM-ER-549, Rev. 1
Formerly WHC-SD-WM-ER-549, Rev. 0

# Tank Characterization Report for Single-Shell Tank 241-B-111


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Date Published
March 1997

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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## CONTENTS

**CONTENTS (Continued)**

CONTENTS (Continued)

## LIST OF FIGURES



## LIST OF TABLES

## LIST OF TABLES (Continued)

## LIST OF TABLES (Continued)

## LIST OF TABLES (Continued)

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## LIST OF TERMS

| | |
|---|---|
| 2C | second-cycle decontamination waste |
| 2C2 | second-cycle decontamination waste (1945 to 1953) |
| AEA | alpha energy analysis |
| ANOVA | analysis of variance |
| ASTM | American Society for Testing and Materials |
| BY saltcake | Saltcake waste generated from in-tank solidification units 1 and 2 between 1965 and 1974 |
| Btu/hr | British thermal units per hour |
| Ci | curies |
| Ci/L | curies per liter |
| cm | centimeter |
| CSR | Waste sent to B-Plant for cesium |
| CVAA | cold vapor atomic absorption |
| DL | detection limit |
| DQO | data quality objective |
| DSC | differential scanning calorimetry |
| DW | decontamination waste |
| dynes/cm$^2$ | dynes per square centimeter |
| EB | evaporator bottoms |
| ECN | Engineering Change Notice |
| FIC | Food Instrument Corporation |
| ft | feet |
| FP | fission products waste |
| g | gram |
| g/L | grams per liter |
| g/mL | grams per milliliter |
| GC/MS | gas chromatography/mass spectrometry |
| GEA | gamma energy analysis |
| GFAA | graphite furnace atomic absorption |
| HAS | Hanford Analytical Services |
| HDW | Hanford defined waste |
| HHF | hydrostatic head fluid |
| HTCE | historical tank content estimate |
| IC | ion chromatography |
| ICP | inductively coupled plasma spectroscopy |
| in. | inch |
| ISE | ion selective electrode |
| IX | ion exchange |
| J/g | joules per gram |
| kg | kilogram |
| kgal | kilogallons |
| kL | kiloliters |

## LIST OF TERMS (Continued)

| | |
|---|---|
| LFL | lower flammability limit |
| m | meter |
| *M* | moles per liter |
| mL | milliliters |
| n/d | not determined |
| NPH | normal paraffin hydrocarbon |
| n/r | not reported |
| P2 | PUREX high-level waste (1964 to 1967) |
| PHMC | Project Hanford Management Contract |
| PUREX | plutonium-uranium extraction |
| ppm | parts per million |
| QA | quality assurance |
| QC | quality control |
| RCRA | *Resource Conservation and Recovery Act* |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SORWT | Sort on Radioactive Waste Type |
| SVOA | semivolatile organic analysis |
| TC | total carbon |
| TCLP | toxicity characteristic leaching procedure |
| TGA | thermogravimetric analysis |
| TIC | total inorganic carbon |
| TLM | Tank Layer Model |
| TOC | total organic carbon |
| TWRS | Tank Waste Remediation System |
| UL | upper limit |
| VOA | volatile organic analysis |
| W | watts |
| WSTRS | Waste Status and Transaction Record Summary |
| wt% | weight percent |
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| μCi/g | microcuries per gram |
| μg/g | micrograms per gram |
| μg/mL | micrograms per milliliter |
| μmol/g | micromoles per gram |

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# 1.0 INTRODUCTION

One major function of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of the waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other available information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendixes serve as the TCR for single-shell tank 241-B-111. The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-B-111 waste, and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. Section 2.0 summarizes the response to technical issues, Section 3.0 provides the best-basis inventory estimate, and Section 4.0 provides recommendations about safety status and additional sampling needs. The appendixes contain supporting data and information. This report also supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996), Milestone M-44-05.

## 1.1 SCOPE

The characterization information in this report originated from sample analyses and known historical sources. The most recent sampling of tank 241-B-111 (September and October 1991) predated the application of data quality objectives (DQOs) to core sampling. An evaluation of the technical issues from the current safety screening DQO (Dukelow et al. 1995) has been performed using the data from the 1991 sampling event. Historical information in Appendix A includes surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model.

Appendix B summarizes the most recent sampling event (see Table 1-1) and the sampling results. There are no pre-1989 sampling events for this tank. The sampling and analysis of the 1991 core samples were performed in accordance with the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (Hill et al. 1991), the results were reported in a laboratory data package (Giamberardini 1993) and summarized in Benar (1996) and Remund et al. (1994). Appendix C reports on the statistical analysis and numerical manipulation of data used in issue resolution. Appendix D contains the evaluation used to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. Appendix E is a bibliography resulting from an in-depth literature search of all known information sources applicable to tank 241-B-111 and its respective waste types. The reports listed in Appendix E can be found in the Tank Characterization Resource Center.

Table 1-1. Summary of Recent Sampling.

| Sample/Date | Phase | Location | Segmentation | Recovery | Mass (g) |
|---|---|---|---|---|---|
| Core 29 (September 1991) | Solid | Riser 3 | No segmentation | Full recovery of four segments. | 944 |
| Core 30 (October 1991) | Solid | Riser 5 | No segmentation | Full recovery for two segments and partial recovery for two segments. | 614 |

## 1.2 TANK BACKGROUND

Tank 241-B-111 is located in the 200 East Area B Tank Farm on the Hanford Site. It is the second tank in a three-tank cascade series. The tank was constructed in 1943 and 1944 and went into service in 1945. From 1945 to 1953, the tank received second-cycle decontamination waste (2C2) from the bismuth phosphate process cascaded from tank 241-B-110. From 1953 to 1959, the tank received waste from various tanks and flush water. From 1961 to 1962 the tank received B Plant decontamination waste. Between 1963 and 1967, PUREX high-level waste, waste from tank 241-B-112, and flush water was transferred to the tank. Between 1969 and 1972, the tank received cesium recovery waste, waste from various tanks, and flush water. The tank was removed from service in 1976, declared an assumed leaker in 1978, and salt well pumped in 1983.

Table 1-2 summarizes a description of tank 241-B-111. The tank has an operating capacity of 2,010 kL (530 kgal) and presently contains an estimated 897 kL (237 kgal) of noncomplexed waste (Hanlon 1996). The tank is not on a Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-B-111.

| | |
|---|---|
| **TANK DESCRIPTION** | |
| Type | Single-shell |
| Constructed | 1943 to 1944 |
| In service | 1945 |
| Diameter | 22.9 m (75.0 ft) |
| Operating depth | 5.2 m (17 ft) |
| Capacity | 2,010 kL (530 kgal) |
| Bottom shape | Dish |
| Ventilation | Passive |
| **TANK STATUS** | |
| Waste classification | Noncomplexed |
| Total waste volume[1] | 897 kL (237 kgal) |
| Supernatant volume | 4 kL (1 kgal) |
| Saltcake volume | 0 kL (0 kgal) |
| Sludge volume | 893 kL (236 kgal) |
| Drainable interstitial liquid volume | 80 kL (21 kgal) |
| Waste surface level (October 2, 1996, manual Food Instrument Corporation [FIC] gauge) | 2.12 m (83.3 in.) |
| Temperature (April 9, 1975 to July 1, 1996) | 12.2 °C (54 °F) to 36.6 °C (98 °F) |
| Integrity | Assumed leaker |
| Watch List | None |
| **SAMPLING DATE** | |
| Core samples | September and October 1991 |
| Tank headspace gas samples | March 1996 |
| **SERVICE STATUS** | |
| Removed from service | April 1976 |
| Interim stabilization | June 1985 |
| Intrusion prevention | October 1985 |

Note:

[1]The waste volume is estimated from surface-level measurements.

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# 2.0 RESPONSE TO TECHNICAL ISSUES

One technical issue has been identified for tank 241-B-111. It is:

- **Safety screening**: Does the waste pose or contribute to any recognized potential safety problems?

The 1991 sampling and 1993 analysis of cores 29 and 30 predates the safety screening DQO (Dukelow et al 1995). However, the analytical results from this sampling event and the tank headspace flammability measurements obtained in 1996 can provide useful information in response to this issue (see Appendix B).

## 2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-B-111 is documented in the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). Potential safety problems include exothermic conditions in the waste, flammable gases in the waste and/or tank headspace, and criticality conditions in the waste. Each condition is addressed separately. Because the core sampling and analysis predate the DQO, this evaluation is provided for information only.

### 2.1.1 Exothermic Conditions (Energetics)

The first requirement in Dukelow et al. (1995) is to ensure exothermic constituents (organic or ferrocyanide) in tank 241-B-111 do not cause a safety hazard. The safety screening DQO requires that waste sample profiles be tested for energetics every 24 cm (half segment) to determine whether the energetics exceed the safety threshold limit. The threshold limit for energetics is -480 J/g on a dry weight basis. Results obtained using differential scanning calorimetry (DSC) indicated no exotherms were observed in any segment of either core.

Based on historical process transfer records, some waste in tank 241-B-111 is expected to contain some exothermic agents. However, historical modeling estimates (Agnew et al. 1996a) and analytical data place organic levels at well below the action limit.

### 2.1.2 Flammable Gas

The tank headspace was sampled and analyzed for the presence of flammable gases in March 1996. Results indicated no flammable gas was detected (0 percent of the lower flammability limit [LFL]). Appendix B provides measurement data.

### 2.1.3 Criticality

The safety threshold limit is 1 g $^{239}Pu$ per liter of waste. Assuming that all total alpha activity is from $^{239}Pu$ and using the highest measured density of 1.3 g/mL 1 g/L of $^{239}Pu$ is equivalent to 46.9 $\mu$Ci/g of alpha activity. By using the highest density result, the lowest threshold limit was obtained in $\mu$Ci/g. Concentrations for both analytes in all samples were approximately 0.1 $\mu$Ci/g, well below the limit. Additionally, as required by the DQO, the upper limit (UL) of the one-sided 95 percent confidence interval for these results were all less than 1 g/L; therefore, criticality is not an issue for this tank. Appendix C contains the method used to calculate the confidence limits and values obtained.

## 2.2 OTHER TECHNICAL ISSUES

Heat generation and waste temperature are factors in assessing tank safety. Because the waste in tank 241-B-111 is radioactive, it generates heat through radioactive decay. Based on results from the 1991 sampling event, the most significant radioactive contributors in the waste are $^{90}Sr$ and $^{137}Cs$, contributing 264,000 and 168,000 curies, respectively. Table 2-1 summarizes the power produced by the radionuclides in the waste. The heat load calculations indicate that 2,570 W (8,771 Btu/hr) of heat are produced in the tank. The heat load estimate based on tank process history was 9,330 W (31,900 Btu/hr) (Agnew et al. 1996a), and the estimate based on the tank headspace temperature was 3,220 W (11,000 Btu/hr) (Kummerer 1995). All three estimates are below the limit of 11,700 W (40,000 Btu/hr) that separates high- and low-heat load tanks (Smith 1986).

Table 2-1. Radionuclide Inventory and Projected Heat Load.

| Analyte | Total Ci | Watts/Ci[1] | Watts |
|---|---|---|---|
| $^{241}Am$ | 90.1 | 0.0328 | 2.96 |
| $^{137}Cs$[2] | 1.68E+05 | 0.00472 | 796 |
| $^{60}Co$ | 4.12 | 0.0154 | 0.0635 |
| $^{242}Cm$ | 0.0979 | 0.0362 | 0.0035 |
| $^{243/244}Cm$ | 0.501 | 0.0344 | 0.0172 |
| $^{154}Eu$ | 181 | 0.00898 | 1.63 |
| $^{155}Eu$ | 213 | 7.23E-04 | 0.155 |
| $^{237}Np$ | 0.0761 | 0.0288 | 0.00181 |
| $^{238}Pu$ | 3.25 | 0.0326 | 0.108 |
| $^{239/240}Pu$ | 104 | 0.0306 | 3.18 |
| $^{90}Sr$[3] | 2.64E+05 | 0.00669 | 1,760 |
| $^{99}Tc$ | 121 | 5.01E-04 | 0.0606 |
| $^{232}Th$ | 0.0324 | 0.0238 | 7.72E-04 |
| Tritium | 2.93 | 0.261 | 0.763 |
| Total | | | 2,570 |

Notes:

[1]Kirkpatrick and Brown (1984)
[2]Includes $^{137}Cs$ and $^{137}Ba$
[3]Includes $^{90}Sr$ and $^{90}Y$

## 2.3 SUMMARY

Not all 1991 core sampling and 1993 analyses were performed to the requirements of Dukelow et al. (1995) because they predate the document. Energetic analyses were not conducted at the half-segment level. As a result, the current safety screening DQOs were not met. However no primary analyte exceeded safety decision threshold limits (see Table 2-2).

Table 2-2. Summary of Safety Screening Evaluation Results.

| Issue | Sub-issue | Result |
|---|---|---|
| Safety screening | Energetics | No exotherms observed in any sample. |
| | Flammable gas | Combustible gas meter reported 0 percent of the LFL. |
| | Criticality | All analyses well below 46.9 $\mu$Ci/g total alpha (within 95 percent confidence limit on each sample). |

# 3.0 BEST-BASIS INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used when performing safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form that is suitable for long-term storage.

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses, and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by the Los Alamos National Laboratory (Agnew et al. 1996). Not surprisingly, information derived from these two approaches is often inconsistent. An effort is underway to provide waste inventory estimates that will serve as standard characterization information for waste management activities (Hodgson and LeClair 1996).

A best-basis inventory estimate for chemical and radionuclide components in tank 241-B-111 follows (see Appendix D). The results from this evaluation are based on sampling data for tank 241-B-111 for the following reasons:

- Analytical results from two widely spaced core samples were used to estimate the component inventories. There is no reason to dispute the analytical results.
- There was no horizontal stratification of the tank.
- Analytical results for the core samples are consistent with the receipt of second cycle decontamination (2C) waste.

These results are subject to future review because of the lack of agreement with the flowsheet projected inventory. Tables 3-1 and 3-2 show the best-basis inventory estimates for tank 241-B-111.

Table 3-1. Sample-Based Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-B-111 (September 30, 1996).

| Analyte | Total Inventory (kg) | Basis (S, M, or E)[1] | Comment RSD Percent[2] |
|---|---|---|---|
| Al | 958 | S | 7 |
| Bi | 21,500 | S | 1 |
| Ca | 734 | S | 23 |
| Cl | 1,090 | S | 2 |
| TIC as $CO_3$ | 23,800 | S | 11 |
| Cr | 1,180 | S | 5 |
| F | 1,660 | S | 2 |
| Fe | 18,900 | S | 5 |
| Hg | 9.93 | S | 50 |
| K | 718 | S | 18 |
| La | 12 | S | 27 |
| Mn | 84.1 | S | 6 |
| Na | 102,000 | S | 2 |
| Ni | 22.1 | S | 7 |
| $NO_2$ | 47,900 | S | 9 |
| $NO_3$ | 87,400 | S | 8 |
| Pb | 1,670 | S | 7 |
| P as $PO_4$ | 51,800 | S | 8 |
| Si | 11,100 | S | 8 |
| S as $SO_4$ | 12,400 | S | 1 |
| Sr | 232 | S | 2 |
| TOC | 932 | S | 12 |
| $U_{TOTAL}$ | 210 | S | 4 |
| Zr | 15.3 | S | 29 |

Notes:

TIC = total inorganic carbon
TOC = total organic carbon

[1]S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based
[2]The uncertainties associated with each mass total are expressed as RSD percent.

Table 3-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-111 (September 30, 1996).

| Analyte | Total Inventory (Ci) | Basis (S, M, or E)[1] | Comment RSD Percent[2] |
|---|---|---|---|
| $^{14}C$ | 1.7 | S | 36 |
| $^{60}Co$ | < 4.12 | S | |
| $^{90}Sr$ | 264,000 | S | 22 |
| $^{99}Tc$ | 121 | S | 10 |
| $^{137}Cs$ | 168,000 | S | 9 |
| $^{154}Eu$ | 181 | S | 26 |
| $^{237}Np$ | 0.0761 | S | 22 |
| $^{239/240}Pu$ | 104 | S | 5 |
| $^{241}Am$ | 90.1 | S | 25 |
| $^{243/244}Cm$ | 0.501 | S | 57 |

Note:

[1]S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based

[2]The uncertainties associated with each mass total are expressed as RSD percent.

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# 4.0 RECOMMENDATIONS

The sampling and analysis of cores 29 and 30 predated the application of DQOs. However, these results were evaluated against the requirements of the safety screening DQO (Dukelow et al. 1995). All analytical results were well within the safety notification limits. The tank can be classified as "safe." A characterization best-basis inventory was developed for tank contents.

Table 4-1 summarizes the status of Project Hanford Management Contract (PHMC) TWRS Program Office review and acceptance of the sampling and analysis results reported in this TCR. Table 4-1 lists the DQO issues addressed by the sampling and analysis. Column 2 indicates whether the requirements of the DQO were met by the sampling and analysis activities performed and is answered "yes" or "no." The third column indicates the concurrence and acceptance by the program in TWRS responsible for the DQO that the sampling and analysis activities performed adequately meet the needs of the DQO. A "yes" or "no" in column 3 indicates acceptance or disapproval of the sampling and analysis information presented in the TCR. If the results and information have not been reviewed, "N/R" is shown; if the results and /information have been reviewed, but acceptance or disapproval has not been decided, "N/D" is shown.

Table 4-1. Acceptance of Tank 241-B-111 Sampling and Analysis.

| Issue | Evaluation Performed | TWRS[1] Program Acceptance |
|---|---|---|
| Safety screening DQO | Yes | Yes |

Note:

[1]PHMC TWRS Program Office

Table 4-2 summarizes the status of TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations in this report include the best-basis inventory evaluation and the evaluation to determine whether the tank is safe, conditionally safe, or unsafe. Column 1 lists the evaluations performed in this report. Columns 2 or 3 are in the same format as Table 4-1. The manner in which concurrence and acceptance are summarized is also the same as that in Table 4-1.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-B-111.

| Issue | Evaluation Performed | TWRS[1] Program Acceptance |
|---|---|---|
| Safety categorization | Yes | Yes |

Note:
[1]PHMC TWRS Program Office

# 5.0 REFERENCES

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# APPENDIX A

# HISTORICAL TANK INFORMATION

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# APPENDIX A

# HISTORICAL TANK INFORMATION

Appendix A describes tank 241-B-111 based on historical information. For this report, historical information includes information about the fill history, waste types, surveillance, or modeling data about the tank. This information is necessary to provide a balanced assessment of the sampling and analytical results.

This appendix contains the following information:

- **Section A1**: Current status of tank 241-B-111, including current waste levels and the stabilization and isolation status.
- **Section A2**: Information about the tank design.
- **Section A3**: Process knowledge of the tank, that is, the waste transfer history and the estimated contents of the tank based on modeling data.
- **Section A4**: Surveillance data, including surface-level readings, temperatures, and a description of the waste surface based on photographs.
- **Section A5**: References for Appendix A.

## A1.0 CURRENT TANK STATUS

As of September 30, 1996, tank 241-B-111 contained an estimated 897 kL (237 kgal) of noncomplexed waste (Hanlon 1996). The waste volume was estimated using an FIC surface-level gauge. Table A1-1 shows the volume estimates of the waste phases found in the tank.

Tank 241-B-111 was removed from service in 1976 and was declared an assumed leaker in 1978. It was interim stabilized in June 1985; intrusion prevention (interim isolation) was completed in October 1985 (Brevick et al. 1994). The tank is passively ventilated, and it is not on the Watch List (Public Law 101-510).

Table A1-1. Tank Contents Summary.[1]

| Waste Type | Volume | |
|---|---|---|
| | kiloliters | kilogallons |
| Total waste | 897 | 237 |
| Supernate | 4 | 1 |
| Sludge | 893 | 236 |
| Saltcake | 0 | 0 |
| Drainable interstitial liquid | 79 | 21 |
| Drainable liquid remaining | 83 | 22 |
| Pumpable liquid remaining | 61 | 16 |

Note:

[1]For definitions and calculation methods refer to Appendix C of Hanlon (1996).

## A2.0 TANK DESIGN AND BACKGROUND

Tank 241-B-111 was constructed during 1943 and 1944. It is one of twelve 2,010 kL (530 kgal) tanks in the B Tank Farm. The tanks were designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F) (Leach and Stahl 1996). Tank 241-B-111 has 11 risers ranging in size from 10 cm (4 in.) to 1.1 m (42 in.) in diameter that provide surface-level access to the underground tank (Alstad 1993). There is one riser through the center of the tank dome and five each on opposite sides of the dome.

Tank 241-B-111 entered service in 1945 as the middle tank in a three-tank cascade that included tanks 241-B-110 and 241-B-112. Many tanks in the Hanford Site tank farms are connected in cascades (groups of tanks that have overflow lines from one to another). Cascaded tanks required fewer connections to be made during waste disposal; consequently, all three tanks were usable without having to connect the active waste transfer line directly to each individual tank. In a cascade arrangement, most solids in the waste slurries routed to the tanks settled in the first tank, and the clarified liquids cascaded to other tanks in the series. Supernate from the final tank in the cascade series was sometimes routed to a disposal trench.

Tank 241-B-111 is constructed of 30-cm (1-ft)-thick reinforced concrete with a 6.4 mm (0.25 in.) mild carbon steel liner (ASTM A283 Grade C) on the bottom and sides and a 38-cm (1.25-ft)-thick domed concrete top. It has a dished bottom with a 1.2-m (4-ft) radius knuckle and a 5.2-m (17-ft) operating depth. The tank sits on a reinforced concrete foundation (Leach and Stahl 1996). Each tank in the B Tank Farm was covered with at least 1.5 m (5 ft) of overburden.

Figure A2-1 shows a tank cross section with the approximate waste levels and a schematic of the tank equipment, and Figure A2-2 shows the riser locations. The surface level is monitored through riser 1 with an FIC gauge. Riser 8 contains a thermocouple tree. Risers 3, 4, 5, and 7 are tentatively available for sampling (Lipnicki 1996). Tank 241-B-111 has four process inlet nozzles and one cascade overflow inlet located about 4.8 m (15.7 ft) from the tank bottom (as measured at the tank wall). Table A2-1 lists tank 241-B-111 risers and nozzles, their sizes, and general use.

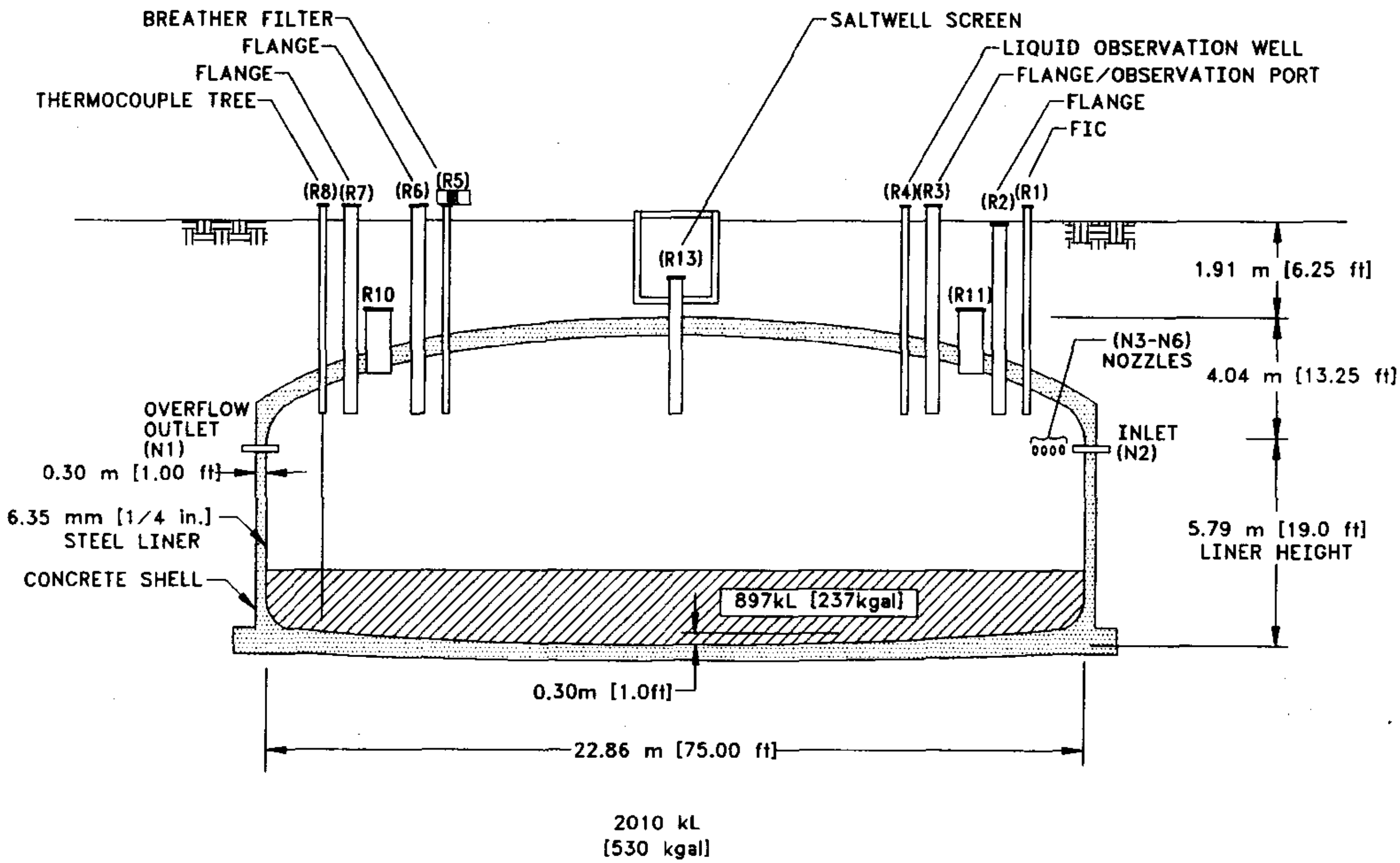



Figure A2-1. Tank 241-B-111 Cross Section and Schematic.

Figure A2-2. Riser Configuration for Tank 241-B-111.

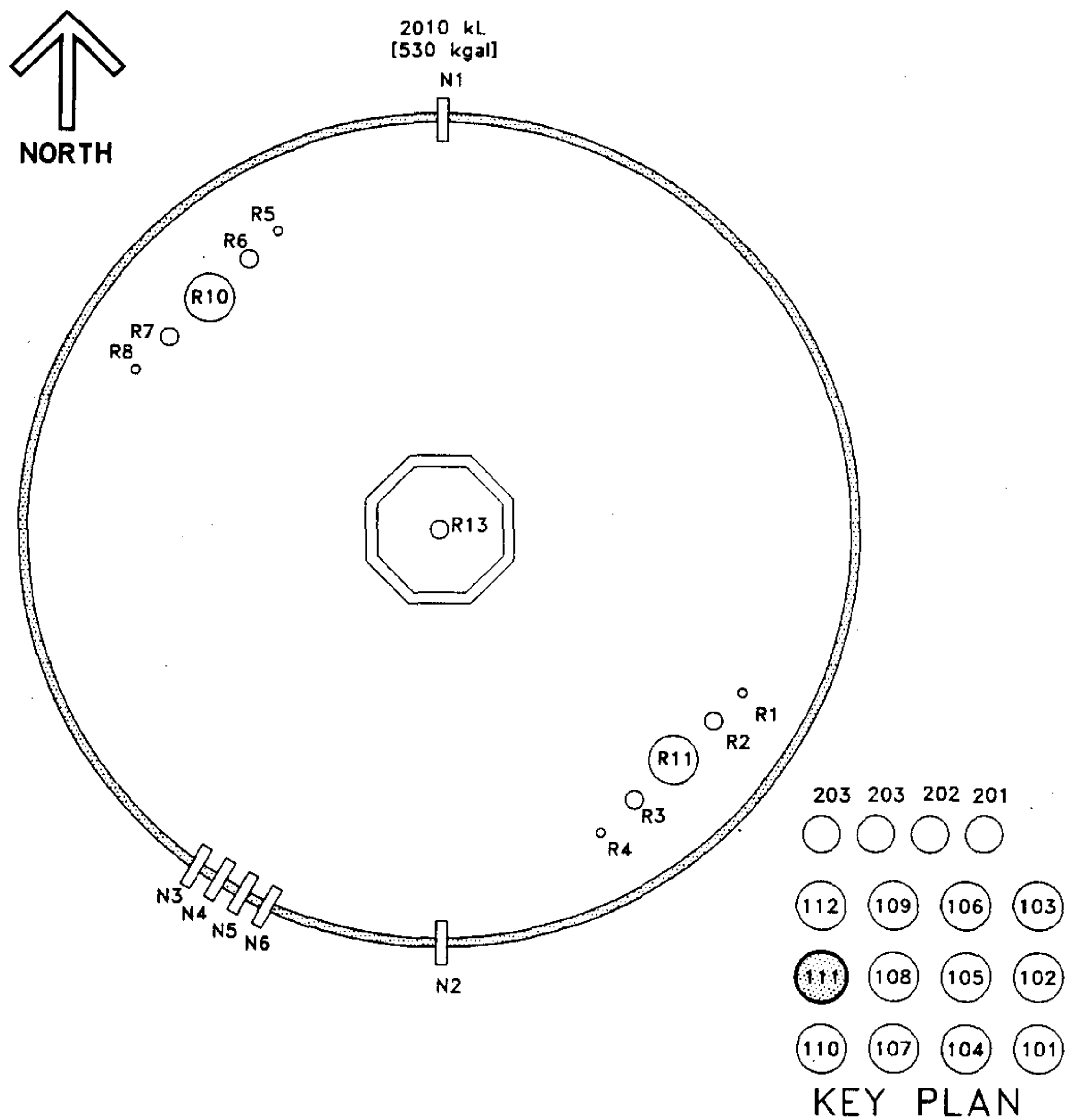


Table A2-1. Tank 241-B-111 Risers and Nozzles.[1]

| Number | Diameter (In.) | Sampling[2] | Description and Comments |
|---|---|---|---|
| 1 | 4 | | FIC surface-level gauge (benchmark) |
| 2 | 12 | | Dip tubes (cut off/blind flanged) |
| 3 | 12 | X | B-222 observation port |
| 4 | 4 | X | Steel liquid observation well ECN-614182 September 27, 1994 |
| 5 | 4 | X | Breather filter (G1 housing) |
| 6 | 12 | | Flange with lead, spare |
| 7 | 12 | X | Blind flange |
| 8 | 4 | | Temperature probe (bench mark) |
| 10 | 42 | | Manhole (below grade) |
| 11 | 42 | | Manhole (below grade) |
| 13 | 12 | | Salt well screen (weather covered) |
| N1 | 3 | | Cascade overflow |
| N2 | 3 | | Cascade inlet |
| N3 | 3 | | Spare |
| N4 | 3 | | Line V-260 |
| N5 | 3 | | Spare |
| N6 | 3 | | Spare |

Notes:

ECN = Engineering Change Notice

[1]Alstad (1993) and Vitro Engineering Corporation (1986)
[2]Risers tentatively available for sampling (Lipnicki 1996)

# A3.0 PROCESS KNOWLEDGE

The following sections 1) provide information about the transfer history of tank 241-B-111, 2) describe the process wastes that made up the transfers, and 3) give an estimate of the current tank contents based on transfer history.

## A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-B-111. The tank initially received 2C waste in December 1945 through the cascade from tank 241-B-110 (Agnew et al. 1996b). This waste originated from the bismuth phosphate process used at B Plant. Tank 241-B-111 was filled in April 1946, then waste cascaded to tank 241-B-112. Tank 241-B-111 continued to receive 2C waste through the first quarter of 1953. Anderson (1990) indicates most liquid waste was pumped from tank 241-B-111 to a crib during the second quarter of 1950.

During the second quarter of 1954, tank 241-B-111 received evaporator bottoms from tank 241-B-105. During the same period, waste cascaded from tank 241-B-111 to tank 241-C-112. Supernate waste from tank 241-B-111 was transferred to tank 241-B-108 during the third quarter of 1995.

From the second quarter of 1957 to the second quarter of 1962, tank 241-B-111 received flush water and decontamination waste (DW) from B Plant. From the second quarter of 1963 to the second quarter of 1969, waste was transferred from tank 241-B-111 to tank 241-B-112. During the same period, tank 241-B-111 continued to receive PUREX high-level waste and flush water.

From the third quarter of 1969 to the second quarter of 1970, tank 241-B-111 received a large amount of waste from cesium recovery operations at B Plant, from tank 241-BY-112, and flush water. During this period, waste was sent from tank 241-B-111 to tanks 241-B-112, 241-B-108, 241-B-109, and 241-B-103. During the first quarter of 1972, waste was sent from tank 241-B-111 to tanks 241-B-103 and 241-BY-112.

Tank 241-B-111 was removed from service in 1976. About 45 kL (12 kgal) of liquid was transferred from tank 241-B-111 and sent to tank 241-AN-103 for interim stabilization during salt well pumping in 1983.

Table A3-1. Tank 241-B-111 Major Transfers.[1,2]

| Transfer Source | Transfer Destination | Waste Type | Period | Estimated Waste Volume[3] | |
|---|---|---|---|---|---|
| | | | | kL | kgal |
| 241-B-110 | | 2C2 | 1945 to 1953 | 20,450 | 5,402 |
| | 241-B-112 | Supernate | 1945 to 1953 | -18,440 | -4,872 |
| 241-B-105 | | Evaporator bottoms | 1954 | 1,060 | 281 |
| | 241-B-112 | Supernate | 1954 | -1,060 | -281 |
| | 241-B-108 | Supernate | 1955 | -1,060 | -281 |
| B Plant | | Flush water | 1957 to 1959 | 314 | 83 |
| B Plant | | DW | 1961 to 1962 | 818 | 216 |
| | 241-B-112 | Supernate | 1963 | -836 | -221 |
| PUREX | | PUREX high-level waste | 1964 to 1967 | 2,530 | 699 |
| | 241-B-112 | Supernate | 1965 to 1967 | -2,270 | -600 |
| Misc. sources | | Flush water | 1966 | 72 | 19 |
| 241-B-112 | | Supernate | 1967 | 367 | 97 |
| | 241-B112 | Supernate | 1969 | -2,700 | -714 |
| B Plant | | Cesium recovery | 1969 to 1970 | 7,093 | 1,874 |
| | 241-B-108 and 241-B-109 | Supernate | 1969 | -3,009 | -795 |
| 241-BY-112 | | Evaporator bottoms | 1969 to 1970 | 348 | 92 |
| | 241-B-103 | Supernate | 1970 to 1972 | -2,750 | -726 |
| | 241-BY-112 | Supernate | 1972 | -79 | -21 |
| | 241-AN-103 | Salt well liquid | 1983 | -45 | -12 |

Notes:

[1]Agnew et al. (1996b)

[2]Because only major transfers are listed, the sum of these transfers will not equal the current tank waste volume.

[3]Positive transfer volumes are amounts transferred to tank 241-B-111; negative transfer volumes are amounts transferred from tank 241-B-111.

## A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The following is an estimate of the contents of tank 241-B-111 based on historical data. The historical data used for the estimate are from the *Waste Status and Transaction Record Summary for the Northeast Quadrant (WSTRS)* (Agnew et al (1996b), the *Hanford Tank Chemical and Radionuclide Inventories: HDW Model, Rev. 3* (this document contains the Hanford Defined Waste [HDW] list, the Supernatant Mixing Model [SMM], the Tank Layer Model [TLM]) (Agnew et al. 1996a), and the *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Areas* (HTCE) (Brevick et al. 1996a). The WSTRS is a balanced tank-by-tank, quarterly summary spreadsheet of waste transactions. In most cases, the available data are incomplete reducing the reliability of the transfer data and the derived modeling results. Using these records, the TLM defines the sludge and saltcake layers within each tank. The SMM uses information from both the WSTRS and TLM to describe the supernates and concentrates within each tank. Together, the WSTRS, TLM, and SMM are used to determine each tank's inventory estimate. Thus, these model predictions are considered estimates only that require further evaluation using analytical data.

Based on Agnew et al. (1996a), tank 241-B-111 contains 4 kL (1 kgal) of supernate, 98 kL (26 kgal) of P2 waste, 4 kL (1 kgal) of DW, and 791 kL (209 kgal) of 2C2 waste. Figure A3-1 is a graphical representation of the estimated waste type and volume for the waste layers. The constituents estimated to be above 1 wt% in 2C2 waste are sodium, iron, nitrate, phosphate, and hydroxide. The constituents estimated to be above 1 wt% of DW are hydroxide, sodium, chromium, nickel, calcium, sulfate, and iron. The constituents estimated to be about 1 wt% in P2 waste are sodium, iron, hydroxide, nitrite, nitrate, uranium, and silicate. The most prevalent radionuclide expected in P2 waste is $Sr^{90}$. Table A3-2 shows the HTCE of the expected waste constituents and their concentrations.

**Figure A3-1. Hanford Defined Wastes Model.**

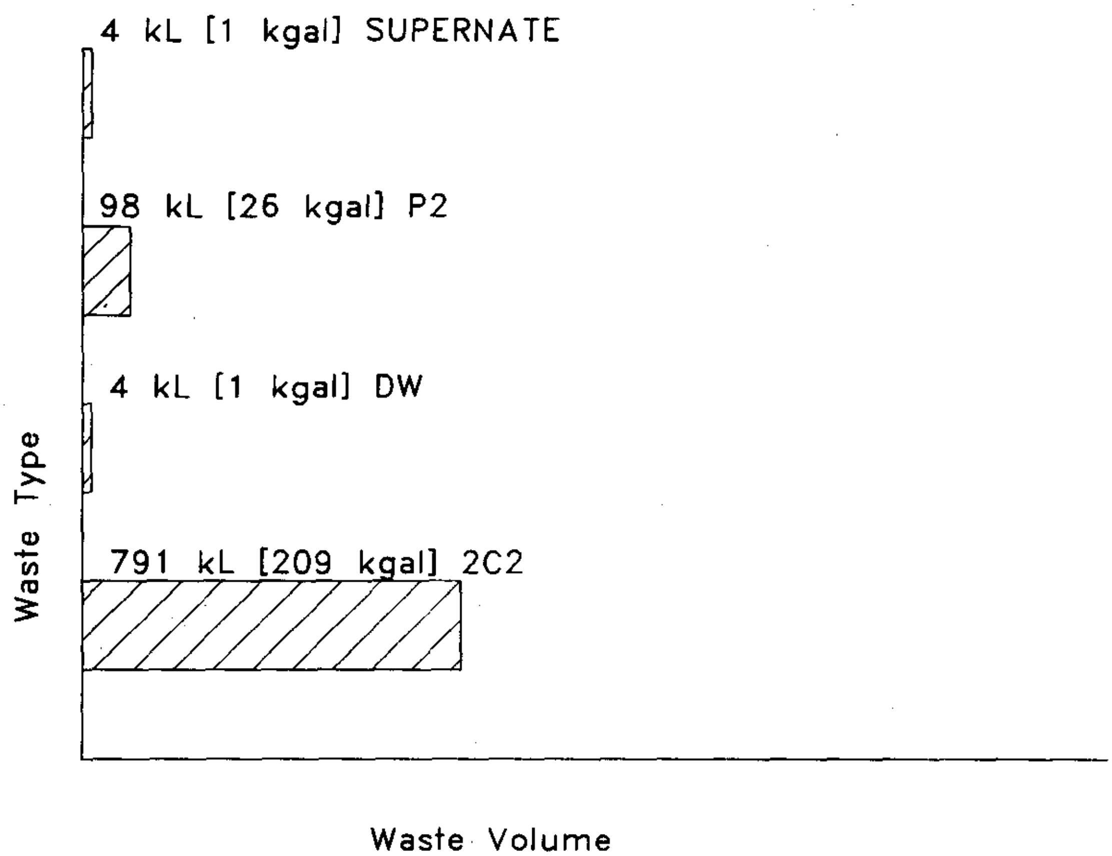


Table A3-2. Tank 241-B-111 Historical Tank Content Estimate.[1,2] (2 sheets)

| Total Inventory Estimate[3] | | | |
|---|---|---|---|
| **Physical Properties** | | | |
| Total waste | 1.04E+06 kg (237 kgal) | | |
| Heat load | 9,330 W (31,900 Btu/hr) | | |
| Bulk density[4] | 1.16 (g/mL) | | |
| Water wt%[4] | 78.2 | | |
| TOC wt%C (wet)[4] | 0.00278 | | |
| **Chemical Constituents** | **M** | **ppm** | **kg** |
| $Na^+$ | 1.54 | 3.05E+04 | 3.18E+04 |
| $Al^{3+}$ | 0.00684 | 159 | 166 |
| $Fe^{3+}$ (total Fe) | 1.03 | 4.98E+04 | 5.18E+04 |
| $Cr^{3+}$ | 0.00875 | 392 | 408 |
| $Bi^{3+}$ | 0.0362 | 6,530 | 6,790 |
| $La^{3+}$ | 1.77E-08 | 0.00212 | 0.00221 |
| $Hg^{2+}$ | 4.28E-08 | 0.0074 | 0.0077 |
| Zr (as $ZrO(OH)_2$) | 1.63E-06 | 0.128 | 0.133 |
| $Pb^{2+}$ | 6.85E-06 | 1.22 | 1.27 |
| $Ni^{2+}$ | 0.00941 | 477 | 496 |
| $Sr^{2+}$ | 5.90E-09 | 4.46E-04 | 4.64E-04 |
| $Mn^{4+}$ | 1.78E-05 | 0.846 | 0.88 |
| $Ca^{2+}$ | 0.274 | 9,480 | 9,860 |
| $K^+$ | 0.00379 | 128 | 133 |
| $OH^-$ | 3.34 | 4.89E+04 | 5.09E+04 |
| $NO_3^-$ | 0.589 | 3.15E+04 | 3.27E+04 |
| $NO_2^-$ | 0.0754 | 2,990 | 3,110 |

Table A3-2. Tank 241-B-111 Historical Tank Content Estimate.[1,2] (2 sheets)

| Total Inventory Estimate[3] | | | |
|---|---|---|---|
| **Chemical Constituents** | ***M*** | **ppm** | **kg** |
| $CO_3^{2-}$ | 0.276 | 1.43E+04 | 1.48E+04 |
| $PO_4^{3-}$ | 0.124 | 1.02E+04 | 1.06E+04 |
| $SO_4^{2-}$ | 0.0394 | 3,270 | 3,400 |
| Si (as $SiO_3^{2-}$) | 0.184 | 4,450 | 4,620 |
| $F^-$ | 0.0968 | 1,590 | 1,650 |
| $Cl^-$ | 0.0172 | 525 | 546 |
| $C_6H_5O_7^{3-}$ | 1.32E-04 | 21.5 | 22.3 |
| $EDTA^{4-}$ | 2.95E-05 | 7.34 | 7.64 |
| $HEDTA^{3-}$ | 3.99E-06 | 0.943 | 0.981 |
| $Glycolate^-$ | 9.27E-05 | 6.00 | 6.24 |
| $Acetate^-$ | 1.76E-04 | 8.95 | 9.31 |
| $Oxalate^{2-}$ | 1.51E-08 | 0.00115 | 0.0012 |
| DBP | 1.40E-04 | 32.1 | 33.4 |
| Butanol | 1.40E-04 | 8.94 | 9.30 |
| $NH_3$ | 0.0266 | 390 | 406 |
| $Fe(CN)_6^{4-}$ | 0 | 0 | 0 |
| **Radiological Constituents** | **Ci/L** | **$\mu$Ci/g** | **Ci** |
| Pu | --- | 0.148 | 2.56 (kg) |
| U | 0.0193 (*M*) | 3,960 ($\mu$g/g) | 4,120 (kg) |
| Cs | 0.0625 | 53.9 | 5.61E+04 |
| Sr | 1.50 | 1,290 | 1.35E+06 |

Notes:

[1]Agnew et al. (1996a)

[2]These estimates have not been validated and should be used with caution.

[3]Unknowns in tank solids inventory are assigned by the TLM.

[4]Volume average for density, mass average water wt% and TOC wt% carbon.

## A4.0 SURVEILLANCE DATA

Tank 241-B-111 surveillance consists of surface-level measurements (liquid and solid), temperature monitoring inside the tank (waste and headspace), and leak detection well (dry well) monitoring for radioactivity outside the tank. Surveillance data provide the basis for determining tank integrity.

Liquid-level measurements can indicate whether the tank has a major leak. Solid surface-level measurements indicate physical changes in and consistency of the solid layers. Dry wells located around the tank perimeter may show increased radioactivity because of leaks.

### A4.1 SURFACE-LEVEL READINGS

An FIC gauge is used to monitor the surface level through riser 1. An automatic FIC had been used in the past, but readings are not available after April 1990. A manual FIC reading of 2.12 m (83.3 in.), a neutron interstitial liquid-level gauge reading of 2.29 m (90.24 in.) and an FIC in intrusion mode reading of 2.14 m (84.4 in.) were measured on October 2, 1996. Figure A4-1 shows the supernate and solid waste levels within tank 241-B-111 from 1945 to 1996. Supernate and sludge levels were taken on a quarterly basis as part of the overall surveillance effort in the tank farms. For surface-level reading in this tank farm, zero on the vertical scale is at the knuckle bottom of the tank. The bottom center of the dish bottom is 30.5 cm (12 in.) below the knuckle bottom.

### A4.2 INTERNAL TANK TEMPERATURES

Tank 241-B-111 has a single thermocouple tree with 11 thermocouples used to monitor waste temperature semiannually through riser 8. Thermocouple elevations were not available (Tran 1993). Thermocouples 2 through 11 are in service. On July 1, 1996, the high temperature in the tank was 21.1 °C (70 °F) at thermocouple 10; the low temperature was 18.7 °C (65.7 °F) at thermocouple 11. These temperature readings were obtained from the Surveillance Analysis Computer System (WHC 1996).

There is a gap in the data from early 1983 to mid 1989 and from late 1989 to mid 1993. The maximum temperature was 36.6 °C (98 °F) recorded at thermocouples 1 and 2 on April 8, 1979. The minimum temperature was 12.2 °C (54 °F) at thermocouple 10 on January 5, 1990. The average temperature for all the readings is 25.6 °C (78.1 °F).

## A4.3 IN-TANK PHOTOGRAPHS

The clearest and most recent set of interior tank photographs was taken on June 26, 1985. A photographic montage is in the *Supporting Document for the Historical Tank Content Estimate for the B-Tank Farm* (Brevick et al. 1994). The montage shows a dark brown sludge surface with pockets of supernate. An unusable recirculating dip tube, salt well screen, temperature probe, and some debris are visible. At the time the photographs were taken, the tank contained approximately 897 kL (237 kgal) of waste. Because the tank has been inactive since the 1970s, the photographic montage should accurately represent the tank interior.

Figure A4-1. Tank 241-B-111 Level History.

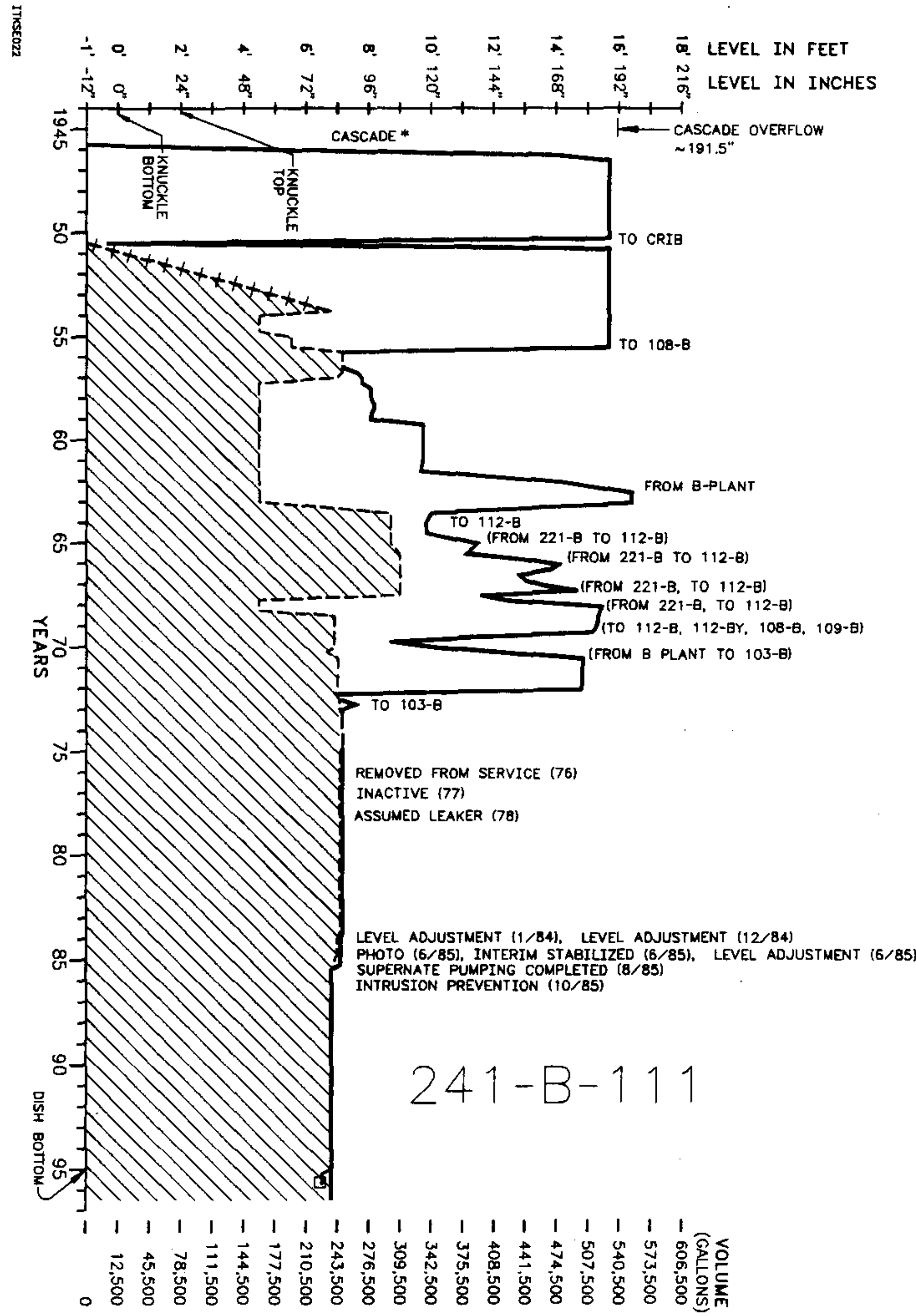
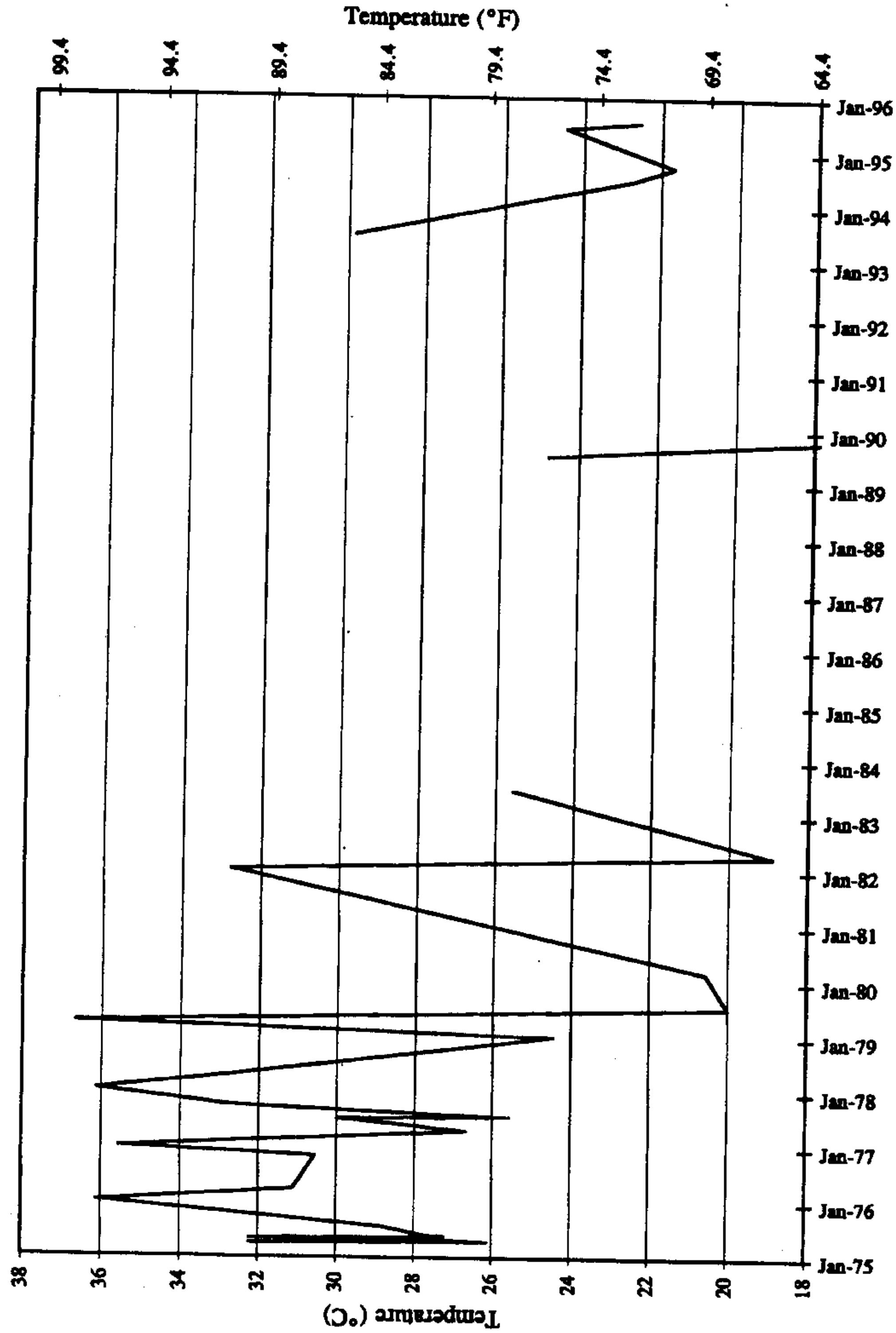


Figure A4-2. Tank 241-B-111 Temperature Plot.



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# APPENDIX B

# SAMPLING OF TANK 241-B-111

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# APPENDIX B

# SAMPLING OF TANK 241-B-111

Appendix B provides sampling and analysis information for each known sampling event for tank 241-B-111 and assesses the core sampling results. It includes the following:

- **Section B1**: Tank Sampling Overview
- **Section B2**: Analytical Results
- **Section B3**: Assessment of Characterization Results
- **Section B4**: References for Appendix B.

Future sampling of tank 241-B-111 will be appended to the above list.

## B1.0 TANK SAMPLING OVERVIEW

This section describes the 1991 sampling and the 1993 analysis for tank 241-B-111. The characterization information supported the design of pretreatment and final waste disposal systems and was used to make risk assessment-based decisions.

The sampling and analysis were performed in accordance with the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (Hill et al. 1991). The sampling event predated DQOs, however, this report evaluates analytical results against the current safety screening DQO (Dukelow et al. 1995). The tank headspace was sampled and analyzed for the presence of flammable gases in March 1996 to satisfy this safety screening DQO requirement. For further discussions of the sampling and analysis procedures, refer to the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994). There are no historical sampling events recorded for this tank.

### B1.1 DESCRIPTION OF SAMPLING EVENT

Two push-mode core samples were taken from tank 241-B-111. Core 29, consisting of four segments, was collected from riser 3 from September 24 to 30, 1991; core 30, also four segments, was collected from riser 5 on the opposite side of the tank on October 2 and 4, 1991. Each segment was delivered to the Pacific Northwest National Laboratory 325 Analytical Chemistry Laboratory. Normal paraffin hydrocarbons (NPH) were used as a hydrostatic head fluid (HHF) during core sampling.

Four complete segments and one partial segment were expected to be recovered from each tank 241-B-111 core (Hill et al. 1991). Segment 1 was not recovered for cores 29 or 30. Segments 2 through 5 were completely recovered for core 29. Segments 3 and 4 were completely recovered for core 30; segments 2 and 5 were partially recovered. After extrusion from the sampler, the core material was placed in glass bottles, sealed, and stored in the high-level radioactive facility. Laboratory analysis and characterization activities were delayed until February 1993 because of waste disposal, funding, and priority issues (Giamberardini 1993).

Although DQOs were not applicable to this sampling event, this report evaluates analytical results against the current safety screening DQO (Dukelow et al. 1995). Two vertical waste profiles were required. Although the riser locations, from which the core samples were taken, met the safety screening requirement of being separated radially to the maximum extent possible, the sample recovery did not fully meet the requirement of two complete vertical profiles. The safety screening DQO requirement that analyses be performed at the half segment level was also not met. The safety screening DQO also requires the determination of the flammability of tank headspace gases. Tank headspace gas sampling was performed on tank 241-B-111 in March 1996. Results indicated no flammable gas was detected (0 percent of the lower flammability limit [LFL]).

## B1.2 SAMPLE HANDLING

The two cores recovered from tank 241-B-111 were similar except that only core 30 contained drainable liquid. Both cores were sludges that held their shape upon extrusion. The flow behavior and bulk density of the solids in segment 5, core 30 indicated some mixing of solid material and drainable liquid. The sample color in both cores varied from dark brown to tan (Giamberardini 1993).

The drainable liquid contained in segments 2 and 5 of core 30 was determined to be HHF. This drainable liquid had a density of 0.80 g/mL and appeared to be organic. Although the density and appearance of the liquid was consistent with the properties of HHF, it was not analyzed.

As shown in Table B1-1, four segments of core 29 were fully recovered. Two segments of core 30 were fully recovered, and two were partially recovered. There was no mention of mechanical failure to account for the partial recoveries of these samples.

The 8 segments from cores 29 and 30 were individually homogenized. Segment 4 of core 29 and segments 3 and 5 of core 30 were subsampled so that analytical tests could be performed to evaluate sample homogenization. After being prepared for analysis by caustic fusion, these subsamples were submitted to the laboratory for gamma energy analysis (GEA), inductively coupled plasma analysis (ICP), and total alpha analysis. Section B3.2 discusses the results.

Table B1-1. Tank 241-B-111 Sample Description.[1]

| Segment | Sample ID | Mass (g) | Volume (mL) | Percent Recovery | Sample Characteristics |
|---|---|---|---|---|---|
| Core 29 - Riser 3 | | | | | |
| 1 | --- | 0 | 0 | 0 | Sampler empty. |
| 2 | 91-081 | 230 | 187 | 100 | Sticky sludges that held shape upon extrusion; soft and creamy texture, but extruded in chunks. The top portion of segment 2 was dark brown, but remaining segments were tan with the exception of streaks of brown in top section of segment 3. |
| 3 | 91-082 | 232 | 187 | 100 | |
| 4 | 91-083 | 243 | 187 | 100 | |
| 5 | 91-084 | 239 | 187 | 100 | |
| Core 30 - Riser 5 | | | | | |
| 1 | --- | 0 | 0 | 0 | Sampler empty. |
| 2 | 91-086 | 38[2] | 30[2] | 16[2] | Solids of segments 2 through 5 similar to solids in core 29. Drainable liquid caused solids in segments 2 and 5 to flow indicating mixing of solids and liquid. |
| 3 | 91-087 | 244 | 187 | 100 | |
| 4 | 91-088 | 245 | 187 | 100 | |
| 5 | 91-089 | 87[2] | 70[2] | 35[2] | |

Notes:

[1]Giamberardini (1993)

[2]Does not include drainable liquid that was determined to be HHF.

Two core composites were built for each core using homogenized aliquots from each segment. The core 29 composite samples were prepared using equal portions from each segment. The core 30 composite samples were prepared using amounts proportional to the solids recovered from each segment (Giamberardini 1993). The composite samples were prepared in duplicate.

The tank headspace gas monitoring was performed using a combustible gas meter, and the flammability was measured as a percent of the lower flammability LFL.

## B1.3 SAMPLE ANALYSIS

An extensive set of analyses were required by Hill et al. (1991) including tests for chemical, physical, and thermodynamic properties. Table B1-2 lists the methods used to assay tank 241-B-111 samples for the suite of requested analyses.

Table B1-2. Sample Preparation and Analytical Methods for Tank 241-B-111 Samples. (2 sheets)

| Analyte | Sample Prep. | Method | Analyte | Sample Prep. | Method |
|---|---|---|---|---|---|
| Aluminum | A, F, W | ICP:A | Antimony | A, F, W | ICP:A |
| Arsenic | A, F, W | ICP:A | Barium | A, F, W | ICP:A |
| Bismuth | A, F, W | ICP:F | Beryllium | A, F, W | ICP:A |
| Boron | A, F, W | ICP:A | Cadmium | A, F, W | ICP:A |
| Calcium | A, F, W | ICP:A | Cerium | A, F, W | ICP:A |
| Chromium | A, F, W | ICP:A | Cobalt | A, F, W | ICP:A |
| Copper | A, F, W | ICP:A | Dysprosium | A, F, W | ICP:A |
| Europium | A, F, W | ICP:A | Gadolinium | A, F, W | ICP:A |
| Iron | A, F, W | ICP:F | Lanthanum | A, F, W | ICP:A |
| Lead | A, F, W | ICP:A | Lithium | A, F, W | ICP:A |
| Magnesium | A, F, W | ICP:A | Manganese | A, F, W | ICP:A |
| Molybdenum | A, F, W | ICP:A | Neodymium | A, F, W | ICP:A |
| Nickel | A, F, W | ICP:A | Palladium | A, F, W | ICP:A |
| Phosphorus | A, F, W | ICP:F | Potassium | A, F, W | ICP:A |
| Rhodium | A, F, W | ICP:A | Ruthenium | A, F, W | ICP:A |
| Selenium | A, F, W | ICP:A | Silicon | A, F, W | ICP:F |
| Silver | A, F, W | ICP:A | Sodium | A, F, W | ICP:F |
| Strontium | A, F, W | ICP:A | Tellurium | A, F, W | ICP:A |
| Thallium | A, F, W | ICP:A | Thorium | A, F, W | ICP:A |
| Tin | A, F, W | ICP:A | Titanium | A, F, W | ICP:A |
| Tungsten | A, F, W | ICP:A | Vanadium | A, F, W | ICP:A |
| Yttrium | A, F, W | ICP:A | Zinc | A, F, W | ICP:A |
| Zirconium | A, F, W | ICP:A | Chloride | W | IC:W |
| Cyanide | W | IC:W | Fluoride | W | IC:W |
| Nitrate | W | IC:W | Nitrite | W | IC:W |
| Phosphate | W | IC:W | Sulfate | W | IC:W |
| Ammonia | W | ISE:W | Mercury | A | CVAA:A |
| $^{243/244}Cm$ | F | Alpha radchem:F | Gross alpha | F | Alpha radchem:F |
| $^{237}Np$ | F | Alpha radchem:F | $^{238}Pu$ | F | Alpha radchem:F |

Table B1-2. Sample Preparation and Analytical Methods for Tank 241-B-111 Samples. (2 sheets)

| Analyte | Sample Prep. | Method | Analyte | Sample Prep. | Method |
|---|---|---|---|---|---|
| $^{239/240}Pu$ | F | Alpha radchem:F | Total alpha | F, W | Alpha radchem:F |
| Gross beta | F, W | Beta radchem:F | $^{90}Sr$ | F | Beta radchem:F |
| $^{99}Tc$ | F | Beta radchem:F | $^{241}Am$ | A, F, W | GEA:F |
| $^{144}Ce$ | A, F, W | GEA:F | $^{134}Cs$ | A, F, W | GEA:F |
| $^{137}Cs$ | A, F, W | GEA:F | $^{60}Co$ | A, F, W | GEA:F |
| $^{154}Eu$ | A, F, W | GEA:F | $^{155}Eu$ | A, F, W | GEA:F |
| $^{40}K$ | A, F, W | GEA:F | Uranium | F | Laser fluorimetry:F |
| $^{239}Pu$ | F | Mass spectrometry:F | $^{240}Pu$ | F | Mass spectrometry:F |
| $^{241}Pu$ | F | Mass spectrometry:F | $^{242}Pu$ | F | Mass spectrometry:F |
| $^{234}U$ | F | Mass spectrometry:F | $^{235}U$ | F | Mass spectrometry:F |
| $^{236}U$ | F | Mass spectrometry:F | $^{238}U$ | F | Mass spectrometry:F |
| Tritium | W | Liquid scintillation:W | $^{14}C$ | W | Liquid scintillation:W |
| $^{59}Ni$ | A | Liquid scintillation:A | $^{63}Ni$ | A | Beta radchem:A |
| TOC | D, W | Persulfate oxidation:W | Hexavalent Chromium | W | Colorimetric:W |
| Total carbon | D, W | Persulfate oxidation:W | TIC | D, W | Persulfate oxidation:W |
| SVOA | --- | GC/MS | VOA | --- | GC/MS |

Notes:

A = acid
D = direct
GC/MS = gas chromatography/mass spectrometry
ICP = inductively coupled plasma
W = water
CVAA = cold vapor atomic absorption
F = fusion
IC = ion chromatography
ISE = ion selective electrode

Analyses have limits imposed between the time a sample is recovered and the analysis (hold time limits). No attempt was made to meet holding time limits for these samples because of waste disposal issues and program priorities. The samples were received on October 8, 1991, and analysis began in February 1993.

A total of 4,625 analytical measurements were made on the tank 241-B-111 samples. Table B1-3 shows a list of sample numbers and applicable analyses. Table B1-4 contains a summary of the analytical result counts. The most complete segment-level analyses were performed on physical properties. All segment-level chemical analyses were homogenization tests. Almost one-third of all analytical results in the data set were quality assurance data (that is, matrix spikes, method blanks, etc.).

The core composite data were used to determine mean concentrations and their associated uncertainties. These values were used to estimate the inventories of the tank 241-B-111 waste constituents. The available segment-level data were used to conduct the sample homogenization tests and to determine the physical properties of tank 241-B-111 waste.

## B1.4 DESCRIPTION OF HISTORICAL SAMPLING EVENTS

There are no historical sampling events for this tank.

Table B1-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

| Segment | Sample Portion | Sample Number | Analyses |
|---|---|---|---|
| **Core 29** | | | |
| 2 | Whole | 93-04312-K1<br>91-081<br>91-10545 | Weight percent solids<br>Bulk density<br>DSC/TGA<br>Particle size distribution |
| 3 | Whole | 93-04312-K2<br>91-082<br><br>91-10549 | Weight percent solids<br>Bulk density, centrifuged solids density,<br>centrifuged supernate density, shear strength<br>DSC/TGA<br>Particle size distribution |
| 4 | Upper 1/2 | 91-10553H-1T<br>91-10553-H1T | ICP (fusion digest)<br>GEA, alpha (fusion digest) |
| | Lower 1/2 | 91-10553H-1B<br>91-10553-H1B | ICP (fusion digest)<br>GEA, alpha (fusion digest) |
| | Whole | 93-04313-K1<br>91-083<br>91-10553 | Weight percent solids<br>Bulk density DSC/TGA<br>Particle size distribution |
| 5 | Whole | 93-04313-K2<br>91-084<br>91-10557 | Weight percent solids<br>Bulk density, centrifuged solids density, centrifuged supernate density, shear strength DSC/TGA<br>Particle size distribution |

Table B1-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

| Segment | Sample Portion | Sample Number | Analyses |
|---|---|---|---|
| Core 29 | | | |
| Composite | Whole | 93-04312 | pH |
| | | 93-04313 | pH |
| | | 93-04312-A,B | GFAA (acid digest) |
| | | 93-04313-A,B | GFAA (acid digest) |
| | | 93-04312-C | cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest) |
| | | 93-04313-C | cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest) |
| | | 93-04312-D | CVAA |
| | | 93-04313-D | CVAA |
| | | 93-04312a1 | ICP (acid digest) |
| | | 93-04313a1 | ICP (acid digest) |
| | | 93-4312h1,c1 | ICP (fusion digest, water digest) |
| | | 93-4313h1,c1 | ICP (fusion digest, water digest) |
| | | 93-04312-C-1 | liquid scintillation counting (water digest) |
| | | 93-04313-C-1 | liquid scintillation counting (water digest) |
| | | 93-04312-H-1 | laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest) |
| | | 93-04313-H-1 | laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest) |
| | | 93-04312-J-1 | SVOA |
| | | 93-04313-J-1 | SVOA |
| | | 93-04312-E1 | liquid scintillation counting |
| | | 93-04313-E1 | liquid scintillation counting |
| | | 93-04312-F1 | ETOX |
| | | 93-04313-F1 | ETOX |
| | | 93-04312-J | TC, TOC, TIC, liquid scintillation counting |
| | | 93-04313-J | TC, TOC, TIC, liquid scintillation counting |
| | | 93-04313-K1 | weight percent solids |
| | | 93-04312-K1 | weight percent solids |
| | | 93-04312-L1 | CVAA for TCLP, ICP for TCLP |
| | | 93-04313-L1 | CVAA for TCLP, ICP for TCLP |

Table B1-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

| Segment | Sample Portion | Sample Number | Analyses |
|---|---|---|---|
| Core 30 | | | |
| 2 | whole | 91-086<br>92-04050 | Bulk density<br>DSC/TGA<br>Particle size distribution |
| 3 | Upper | 92-04054H-1T<br>92-04054-H1T | ICP (fusion digest)<br>GEA, alpha (fusion digest) |
| | Lower | 92-04054H-1B<br>92-04054-H1B | ICP (fusion digest)<br>GEA, alpha (fusion digest) |
| | Whole | 93-04316-K1<br>91-087<br>92-04054 | Weight percent solids<br>Bulk density DSC/TGA<br>Particle size distribution |
| 4 | Whole | 93-04316-K2<br>91-088<br>92-04058 | Weight percent solids<br>Bulk density<br>DSC/TGA<br>Particle size distribution |
| 5 | Upper half | 92-04062H-1T<br>92-04062-H1T | ICP (fusion digest)<br>GEA, alpha (fusion digest) |
| | Lower half | 92-04062H-1B<br>92-04062-H1B | ICP (fusion digest)<br>GEA, alpha (fusion digest) |
| | Whole | 93-04319-K1<br>91-089<br>92-04062 | Weight percent solids<br>Bulk density DSC/TGA<br>Particle size distribution |

Table B1-3. Tank 241-B-111 Summary of Samples and Analyses. (4 sheets)

| Segment | Sample Portion | Sample Number | Analyses |
|---|---|---|---|
| Core 30 (Continued) | | | |
| Composite | Whole | 93-04316 | pH |
| | | 93-04317 | pH |
| | | 93-04316-A,B | GFAA (acid digest) |
| | | 93-04317-A,B | GFAA (acid digest) |
| | | 93-04316-C | cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest) |
| | | 93-04317-C | cyanide, colorimetry, IC, ISE, TC, TOC, TIC (water digest) |
| | | 93-04316-D | CVAA |
| | | 93-04317-D | CVAA |
| | | 93-04316a1 | ICP (acid digest) |
| | | 93-04317a1 | ICP (acid digest) |
| | | 93-4316h1,c1 | ICP (fusion digest, water digest) |
| | | 93-4317h1,c1 | ICP (fusion digest, water digest) |
| | | 93-04316-C-1 | liquid scintillation counting (water digest) |
| | | 93-04317-C-1 | liquid scintillation counting (water digest) |
| | | 93-04316-H-1 | laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest) |
| | | 93-04317-H-1 | laser fluorimetry, GEA, mass spectrometry, alpha, beta rad, liquid scintillation counting (fusion digest) |
| | | 93-04316-J-1 | liquid scintillation counting |
| | | 93-04317-J-1 | liquid scintillation counting |
| | | 93-04312-E1 | SVOA |
| | | 93-04313-E1 | SVOA |
| | | 93-04312-F1 | ETOX |
| | | 93-04313-F1 | ETOX |
| | | 93-04312-J | TC, TOC, TIC |
| | | 93-04313-J | TC, TOC, TIC |
| | | 93-04313-K1 | weight percent solids |
| | | 93-04312-K1 | weight percent solids |
| | | 93-04317-L1 | ICP for TCLP, CVAA for TCLP |

Note:

TGA = thermogravimetric analysis

[1]Giamberardini (1993)

Table B1-4. Summary of Tank 241-B-111 Analytical Result Counts.

| Analyses | | Segment 1 | Segment 2 | Segment 3 | Segment 4 | Segment 5 | Composite | Totals |
|---|---|---|---|---|---|---|---|---|
| Physical properties | Core 29 | 0 | 42 | 47 | 50 | 55 | 6 | 200 |
| | Core 30 | 0 | 48 | 50 | 46 | 49 | 6 | 199 |
| Chemical analyses | Core 29 | 0 | 0 | 0 | 196 | 0 | 1,096 | 1,292 |
| | Core 30 | 0 | 0 | 196 | 0 | 196 | 1,063 | 1,455 |
| Quality assurance (QA) data | | 0 | 0 | 0 | 49 | 49 | 1,381 | 1,479 |
| Totals | | 0 | 90 | 293 | 341 | 349 | 3,552 | 4,625 |

# B2.0 ANALYTICAL RESULTS

## B2.1 OVERVIEW

This section summarizes the sampling and analytical results associated with the 1991 sampling and the 1993 analysis of tank 241-B-111, and the tank headspace gas monitoring performed in March 1996. Table B2-1 describes the chemical, physical, and thermodynamic results in this document. Results were taken from Giamberardini (1993).

Table B2-1. Analytical Presentation Tables.

| Analysis | Table Number |
|---|---|
| Metals by graphite furnace atomic absorption | B2-2 through B2-4 |
| Mercury by cold vapor atomic absorption | B2-5 |
| Metals by inductively coupled plasma spectroscopy | B2-6 through B2-40 |
| Hexavalent chromium by colorimetry | B2-41 |
| Uranium by laser fluorimetry | B2-42 |
| Anions by ion chromatography | B2-43 through B2-49 |
| Ammonia by ion selective electrode | B2-50 |
| Extractable organic halides | B2-51 |
| Semivolatile organic analysis | B2-52 through B2-61 |
| Analyses for total carbon/total organic carbon/total inorganic carbon | B2-62 through B2-67 |
| Radionuclides by gamma energy analysis | B2-68 through B2-72 |
| Radionuclides by mass spectrometry | B2-73 through B2-76 |
| Radionuclides by alpha proportional counting and alpha energy analysis | B2-77 through B2-84 |
| Radionuclides by beta proportional counting | B2-85 through B2-87 |
| Radionuclides by liquid scintillation | B2-88 through B2-91 |
| Analyses for physical and rheological properties | B2-92 through B2-98 |
| Analyses for thermodynamic properties | B2-99 through B2-100 |
| Analyses for headspace flammability | B2-101 |

Data was validated in accordance with Hill et al. (1991). Quality control (QC) and quality assurance (QA) parameters included standard recoveries, spike recoveries, duplicate analyses, and blanks. Section B3.3 summarizes data validation findings.

The following sections discuss the methods used in analyzing the core samples.

## B2.2 INORGANIC ANALYSES

### B2.2.1 Graphite Furnace Atomic Absorption

Graphite furnace atomic absorption (GFAA) analyses for arsenic, selenium, and antimony were performed on the core composite samples (Giamberardini 1993). The samples were analyzed using procedures PNL-ALO-214, PNL-ALO-215, and PNL-ALO-219 for arsenic, selenium, and antimony respectively. Arsenic and selenium were analyzed from $HNO_3$ digestions, and antimony was analyzed from $HNO_3/HCl$ digestions. All results were below the detection limit (Giamberardini 1993).

### B2.2.2 Cold Vapor Atomic Absorption

A mercury analysis was performed on the core composites by CVAA using a modification of procedure PNL-ALO-213 (Giamberardini 1993). The modification changed the sample size, digestion volume, and heating method. The results ranged from 4 to 16 $\mu$g/g.

### B2.2.3 Toxicity Characteristic Leaching Procedure

A TCLP was performed on the core composites. Both composites were leached using procedure PNL-ALO-110 (Giamberardini 1993). The leachate was then digested using acid to determine the concentrations of arsenic, barium, cadmium, chromium, lead, selenium, and silver using ICP. Mercury was analyzed in the leachate using CVAA.

The only analytes at or above the regulatory level were mercury and chromium. Mercury levels ranged from 0.21 to 0.39 $\mu$g/g, and chromium levels ranged from 12.2 to 14.8 $\mu$g/g. All other analytes, including silver which showed poor spike/control recovery, are well below the regulatory level. When compared to the water leach ICP results, all the water soluble chromium appears to be extracted by the TCLP. For further detail regarding the TCLP results, refer to Giamberardini (1993).

### B2.2.4 Inductively Coupled Plasma

Analyses for the waste's metallic constituents were performed by ICP (Giamberardini 1993). The ICP analyses were run after fusion, acid, and water digestions for most but not all analytes. Fusions were prepared from core 29 samples (two composites and segment 4) and core 30 samples (segments 3 and 5) using procedure PNL-ALO-102. Acid digestions were prepared from core 29 and 30 composites using procedure PNL-ALO-101. Water leaches were prepared from core 29 and 30 composites using procedure PNL-ALO-103. The fusions, digestions, and leachates were analyzed following procedure PNL-ALO-211 on a Jarrell-Ash ICP system.

Analytes present in large amounts included sodium, bismuth, iron, and phosphorus. Results ranged from 16,000 to 20,000 $\mu$g/g. Sodium levels were as high as 99,398 $\mu$g/g. Aluminum, calcium, chromium, lead, potassium, and silicon results ranged from 700 to 18,000 $\mu$g/g. Copper, magnesium, manganese, strontium, and zinc results ranged from 36 to 409 $\mu$g/g. Analytes present in smaller amounts included antimony, barium, boron, cadmium, cobalt, molybdenum, nickel, selenium, silver, tellurium, vanadium, total uranium, and zirconium. Lathanam, palladium, and yttrium were not detected.

Interelement corrections for spectral interferences were performed online, and the reported instrument detection limits were determined in accordance with the statement of work and technical project plan requirements.

### B2.2.5 Colorimetry

Analyses for chromium (VI) were performed by colorimetry on core composite samples that had been water leached (Giamberardini 1993). The samples were analyzed using procedure PNL-ALO-227. Results ranged from 142 to 185 $\mu$g/g.

### B2.2.6 Laser Fluorimetry

Total uranium concentrations were measured on the KOH fusion preparations of core 29 and 30 composite samples using laser fluorimetry. No procedure number was provided in Giamberardini (1993). Results ranged from 186 to 206 $\mu$g/g.

### B2.2.7 Ion Chromatography

Ion chromatography analyses were performed on water leachates prepared from core 29 and core 30 composite samples (Giamberardini 1993). They were analyzed for the anions fluoride, chloride, nitrite, nitrate, phosphate, and sulfate using procedure PNL-ALO-212. Nitrate and nitrite were present in amounts ranging from 75,000 to 89,000 $\mu$g/g, and 40,500 to 49,500 $\mu$g/g respectively. Phosphate and sulfate were present in smaller amounts with results ranging 23,100 to 25,300 μg/g and 11,300 to 11,950 μg/g, respectively. Fluoride and chloride had results ranging from 1,000 to 1,500 μg/g. Samples were also analyzed for free cyanide using procedure PNL-ALO-271. Results ranged from less than the detection limit to 2.9 μg/g. The lowest calibration standard for each analyte is defined as the method detection limit.

#### B2.2.8 Ion Selective Electrode

Analyses for ammonia were performed on water-leached core composite samples using procedure PNL-ALO-226. No distillation procedure was performed on the samples because the ISE analysis is performed directly on the leachates (Giamberardini 1993). Results ranged from 22 to 66 μg/g.

### B2.3 ORGANIC ANALYSES

#### B2.3.1 Extractable Organic Halides

Core 29 and 30 composite samples were analyzed for the presence of extractable organic halides using method PNL-ALO-320. All results were less than the detection limit (Giamberardini 1993).

#### B2.3.2 Semivolatiles

Semivolatile organic compounds were analyzed on core 29 and 30 composites by GC/MS. The samples were extracted using procedure PNL-ALO-120 and analyzed using procedure PNL-ALO-345 (Giamberardini 1993). Results of specific compounds include tridecane ranging from 740 to 3,050 μg/g, tetradecane and dodecane ranging from 230 to 1,800 μg/g, and pentadecane ranging from 21 to 99 μg/g. Compounds present in smaller amounts included dioctyl adipate, undecane, and dodecane,4,6-dimethyl.

### B2.4 CARBON ANALYSES

Results for TOC, TIC, and total carbon (TC) are obtained during the same analysis; therefore, the discussion of the analytical method for the three analytes has been combined.

The TOC/TIC/TC analyses were performed direct and on water leachates prepared from core 29 and 30 composites (Giamberardini 1993). Water leachates were analyzed using procedure PNL-7-40.7. Direct analyses were performed using procedure PNL-ALO-381.

Results from the TC analyses range from 4,00 to 5,765 $\mu g/g$. The TOC and TIC results range from 615 to 1,605 $\mu g/g$ and 3,960 to 5,110 $\mu g/g$, respectively.

The TOC results for water leach analysis are similar to those obtained from the direct hot persulfate analysis suggesting that most, if not all, of the organic carbon is soluble. The soluble TOC may contribute slightly to the interferences observed in the fluoride and chloride IC analyses (Giamberardini 1993).

## B2.5 RADIONUCLIDE ANALYSES

A full suite of radiochemical analyses were performed on water and the KOH fusion preparations of core 29 and 30 composite samples. Some analyses (GEA and total alpha analysis [AEA]) were performed on the homogenization tests samples (that is, core 29, segment 4; and core 30, segments 3 and 5). Results are based on the wet weight of the sample. Procedure numbers for most preparations and analyses were not given in Giamberardini (1993).

### B2.5.1 Gamma Energy Analysis

A GEA was performed on core composite samples and homogenization test segment samples prepared by caustic fusion (Giamberardini 1993). Results of specific radionuclides include $^{137}Cs$, ranging from 144 to 177 $\mu g/g$; and $^{241}Am$, $^{154}Eu$, $^{155}Eu$, and $^{60}Co$, ranging from below detection limits to 0.27 $\mu Ci/g$. The emphasis in the homogenization tests was on the detection of $^{137}Cs$. Results were decay corrected to January 1, 1993.

### B2.5.2 Mass Spectrometry

Thermal ionization mass spectrometry was used to determine the presence of all isotopes of U (Giamberardini 1993). Because the Pu content of these samples was low, isotopic composition by mass spectrometry was not possible. However, isotopic information is available from the AEA of the separated plutonium.

### B2.5.3 Total Alpha Activity, Pu, Am/Cm, and Np Analysis

Total alpha activity, Pu, Am/Cm, and Np analyses were performed on KOH fusions of the core composite samples (Giamberardini 1993). Total alpha was also measured on the homogenization samples. The total activity was determined by drying a small aliquot on a counting plate and counting the plate. The Pu, Am/Cm, and Np fractions were separated by ion exchange and/or solvent extraction procedures, then counted. The Pu analyses were reported as total alpha Pu because the Pu concentration of the samples was too low for isotopic determination by mass spectrometry. Plutonium-239/240 and $^{238}Pu$ from the AEA of the separated Pu were also reported. Separation of Am and Pu was not complete; therefore, a correction based on the AEA of the Pu and Am was required, and an additional 10 percent was added to the estimated error of the measurement. Total alpha results ranged from 1.61E-1 to 1.95E-1 $\mu$Ci/g. Results of specific radionuclides include $^{241}$Am ranging from 5.56E-2 to 8.87E-2 $\mu$Ci/g, $^{239/240}$Pu ranging from 8.18E-2 to 1.06E-1 $\mu$Ci/g, $^{243/244}$Cm ranging from 1.35E-4 to 1.27E-3 $\mu$Ci/g, and $^{237}$Np ranging from 5.20E-5 to 1.10E-4 $\mu$Ci/g. Total alpha Pu results ranged from 8.52E-2 to 1.10E-1 $\mu$Ci/g.

### B2.5.4 Total Beta, $^{90}$Sr, and $^{99}$Tc

Total beta, $^{90}$Sr, and $^{99}$Tc analyses were performed on the KOH fusions of the composites from both cores (Giamberardini 1993). Total beta values were determined by drying a small aliquot of each solution and counting in a beta proportional counter. Technetium-99 and $^{90}$Sr were also measured by beta counting after separating each fraction by ion exchange and/or solvent extraction. Total beta results ranged from 524 to 734 $\mu$Ci/g. Results of $^{90}$Sr and $^{99}$Tc measurements ranged from 172 to 308 $\mu$Ci/g and from 9.93E-2 to 1.27E-1 $\mu$Ci/g, respectively.

### B2.5.5 Liquid Scintillation Counting

Carbon-14 was determined by the hot persulfate oxidation/liquid scintillation counting method (PNL-ALO-482). Carbon-14 analyses were performed direct and on water leachates from core composite samples. For water leach samples, a process dilution factor of about 100 times is used causing most results to be below method detection limits (Giamberardini 1993).

Selenium-79 was detectable at very low activity levels in all samples except the preparation blanks.

The analysis of tritium blanks showed possible gross contamination of the core composite samples during preparation in the hot cell. This was attributed to a recurring problem of high residual tritium levels in the Shielded Analytical Laboratory.

## B2.6 PHYSICAL ANALYSES

Measurements of physical characteristics such as weight percent solids, penetration resistance, shear strength, particle size, and settling behavior were taken. General physical assays were performed on samples from core 29. Particle size assays were performed on duplicate samples taken from unhomogenized segments from both core 29 and 30. Shear strength was run on unhomogenized segments from core 29. Because holding time was exceeded, shear strength is a qualified estimate.

### B2.6.1 Penetration Resistance

The penetration resistance was measured according to procedure PNL-ALO-506, Rev. 0, on each extruded segment except for core 30, segment 2 (Giamberardini 1993). The volume of solids in this segment was too small to measure. The penetration measurement was made on unhomogenized segment material before further subsampling. These measurements were made after the sample had been sealed in a bottle for approximately one year. The penetration resistance for all segments was below the detection limit of the penetrometer (less than 1 pound per square inch); therefore, the sludge is cohesive.

### B2.6.2 Weight Percent Solids

The weight percent total solids analyses were performed on samples from the core composites and duplicate samples according to technical procedure PNL-ALO-504 (Giamberardini 1993). This analysis is a gravimetric determination of the weight percent solids as measured by the loss of mass in the sample after drying in an oven at 105 °C (221 °F) for 24 hours. The segment data was obtained on unhomogenized material in the PNNL 325 High level Radiochemistry Facility, and the reported core composite data was obtained in the Shielded Analytical Laboratory on homogenized core composite material. The weight percent total solids ranged from 36.3 to 37.9 on the composite samples.

### B2.6.3 Density

Bulk density was determined for samples from segments 2, 3, 4, and 5 of cores 29 and 30. Results ranged from 0.9 to 1.3 g/mL, with an overall tank density of 1.19 g/mL. Density of centrifuged solids and of centrifuged supernate was determined for samples from segments 3 and 5 of core 29. The centrifuged solids density results were 1.38 and 1.45 g/mL and the centrifuged supernate density results were 1.15 and 1.17 g/mL (Giamberardini 1993).

### B2.6.4 Shear Strength

The shear strength of the waste was measured on unhomogenized segment samples from segments 3 and 5 of core 29. The shear strength measurements were made at ambient temperature using a shear vane connected to a viscometer and rotated at 0.3 revolutions per minute according to procedure PNL-ALO-501. Shear strength is a semiquantitative measurement of the force required to displace the sample. Because shear strength is affected by sample handling, the measurement was taken without sample homogenization (Giamberardini 1993). The shear stress of the material exceeded the baseline value for the measurement system (300 dynes/cm$^2$) in only one of two cases. Because of the long lag time between sampling and analysis, these should be considered estimates.

### B2.6.5 Particle Size Analysis

Particle size distribution was measured on unhomogenized samples from each segment (Giamberardini 1993). A particle size analyzer was used according to procedure PNL-ALO-530, Rev. 0, to determine particle size in the range of 0.5 to 150 microns. Most particles in these samples were less than 20 microns in diameter. The volume density data indicate there is a small percent of particles of much larger size, but it appears only a few particles exceed 100 microns in diameter.

### B2.6.6 pH Measurement

The pH of the water leachates of both core composite materials was measured according to procedure PNL-ALO-225 (Giamberardini 1993). Measurement ranged from 8.74 to 8.98.

## B2.7 THERMODYNAMIC ANALYSES

Thermogravimetric analysis (TGA) and DSC are techniques used to determine the thermal stability or reactivity of a material. Differential scanning calorimetry measures heat released or absorbed while the temperature of the sample is increased at a constant rate. It is often used to measure thermal decomposition temperatures, heats of reaction, reaction temperatures, melting points, and solid-solid transition temperatures. Thermogravimetric analysis measures the mass of a sample while the temperature is increased at a constant rate. It is used to measure thermal decomposition temperatures, water contents, and reaction temperatures. Both methods can be modified to measure isothermal change in the material and provide complimentary information.

### B2.7.1 Thermogravimetric Analysis

Thermogravimetric analysis was performed on unhomogenized material from each segment of cores 29 and 30 (Giamberardini 1993). The balance of the thermogravimetric analyzer was checked with a 100 milligrams standard weight, and the temperature calibration of the analyzer was checked with alumel and perkalloy curie point magnetic transition standards.

### B2.7.2 Differential Scanning Calorimetry

Differential scanning calorimetry was performed on aliquots from each unhomogenized segment from cores 29 and 30 (Giamberardini 1993). An indium standard was run on the differential scanning calorimeter to check the temperature and enthalpy calibrations.

No exothermic transitions were observed and because thermal measurements were made on aliquots from all segments of both cores, it is relatively certain that no exothermic layer exists in this waste (Benar 1996). However, the thermal analysis did identify four endotherms in the waste, which absorbed approximately 300 calories per gram in total. These endotherms occurred at approximately 94, 176, 219, and 310 °C, (201.2, 348.8, 426.2, and 590 °F) with 95 percent of the endothermic behavior occurring between ambient and 140 °C (284 °F). The other endotherms are much smaller and may represent fluctuations associated with the baseline or stages in a series of endothermic events. Because of the relatively close proximity of transitions 2 and 3 in temperature, their relatively small size, the qualitative nature of the assay, and the fact that no corresponding mass loss was observed during the TGA, these endotherms are not considered fully credible. However, the endotherm observed with transition 4 had a more substantial signal in the DSC. Therefore, this endotherm is considered credible and potentially represents a physiochemical process occurring in the waste in that temperature range (277 to 500 °C) (530.6 to 932 °F). Because no exotherms were observed in the analyses of tank 241-B-111 waste, DSC data tables are not provided in this document. For additional data, refer to Giamberardini (1993).

## B2.8 VAPOR PHASE MEASUREMENT

The vapor phase flammability measurements were taken from the tank 241-B-111 headspace on March 19, 1996. These measurements support the safety screening DQO (Dukelow et al. 1995).

## B2.9 ANALYTICAL DATA TABLES

Table B2-2. Tank 241-B-111 Analytical Results: Antimony (AA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | $\mu$g/g | $\mu$g/g | $\mu$g/g |
| 93-04312-A | Core 29 composite | Whole | < 1.9 | < 1.8 | < 1.9 |
| 93-04313-A | | Whole | < 1.8 | < 1.7 | < 1.8 |
| 93-04316-A | Core 30 composite | Whole | < 1.9 | < 1.9 | < 1.9 |
| 93-04317-A | | Whole | < 1.8 | < 1.8 | < 1.8 |

Table B2-3. Tank 241-B-111 Analytical Results: Arsenic (AA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | μg/g | μg/g | μg/g |
| 93-04312-B | Core 29 composite | Whole | < 3.0 | < 2.9 | < 3.0 |
| 93-04313-B | | Whole | < 2.9 | < 2.9 | < 2.9 |
| 93-04316-B | Core 30 composite | Whole | < 2.9 | < 2.9 | < 2.9 |
| 93-04317-B | | Whole | < 2.9 | < 2.9 | < 2.9 |

Table B2-4. Tank 241-B-111 Analytical Results: Selenium (AA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | μg/g | μg/g | μg/g |
| 93-04312-B | Core 29 composite | Whole | < 15 | < 15 | < 15[QC:c] |
| 93-04313-B | | Whole | < 14 | < 15 | < 15 |
| 93-04316-B | Core 30 composite | Whole | < 15 | < 14 | < 15[QC:c] |
| 93-04317-B | | Whole | < 15 | < 14 | < 15 |

Table B2-5. Tank 241-B-111 Analytical Results: Mercury (CVAA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-D | Core 29 composite | Whole | 4.6 | 3.9 | 4.3 |
| 93-04313-D | | Whole | 5.1 | 5.0 | 5.1 |
| 93-04316-D | Core 30 composite | Whole | 13 | 11 | 12 |
| 93-04317-D | | Whole | 19 | 13 | 16 |
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 0.22 | 0.20 | 0.21 |
| 93-04313-L1 | | Whole | 0.21 | 0.22 | 0.22 |
| 93-04317-L1 | Core 30 composite | Whole | 0.39 | n/d[1] | 0.39 |

Note:
[1]n/d = not determined

Table B2-6. Tank 241-B-111 Analytical Results: Aluminum (ICP). (2 sheets)

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 893 | n/d | 893 |
| 93-04312a1 | | Whole | 852 | 834 | 843 |
| 93-04313a1 | | Whole | 788 | 823 | 806 |
| 93-04316a1 | Core 30 composite | Whole | 946 | 968 | 957 |
| 93-04317a1 | | Whole | 986 | n/d | 986 |
| 93-04317a1 | | Whole | 961 | 966 | 963.5 |
| Solids: Fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 212 | 256 | 234 |
| 91-10553H-1T | | Upper half | 211 | 249 | 230 |
| 92-04054H-1B | 30: 3 | Lower half | 1,680 | 1,440 | 1,560 |
| 92-04054H-1T | | Upper half | 1,320 | 1,340 | 1,330 |
| 92-04062H-1B | 30: 5 | Lower half | 1,750 | 1,880 | 1,810 |

Table B2-6. Tank 241-B-111 Analytical Results: Aluminum (ICP). (2 sheets)

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: Fusion digest | | | µg/g | µg/g | µg/g |
| 92-04062H-1T | | Upper half | 1,660 | 1,780 | 1,720 |
| 93-4312h1 | Core 29 composite | Whole | 1,150 | 1,110 | 1,130 |
| 93-4313h1 | | Whole | 1,130 | 1,190 | 1,160 |
| 93-4316h1 | Core 30 composite | Whole | 1,610 | 1,630 | 1,620 |
| 93-4317h1 | | Whole | 1,570 | 1,510 | 1,540 |
| Solids: Water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 11 | < 11 | < 11 |
| 93-4313c1 | | Whole | < 12 | < 9.2 | < 10 |
| 93-4316c1 | Core 30 composite | Whole | < 11 | < 8.9 | < 9.8 |
| 93-4317c1 | | Whole | < 11 | 15 | < 13 |

Table B2-7. Tank 241-B-111 Analytical Results: Antimony (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | < 10 | < 9.5 | < 9.7 |
| 93-04313a1 | | Whole | 10 | 10 | 10 |
| 93-04316a1 | Core 30 composite | Whole | 12 | 15 | 14 |
| 93-04317a1 | | Whole | < 9.5 | < 9.8 | < 9.8 |

Table B2-8. Tank 241-B-111 Analytical Results: Arsenic (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 0.20 | 0.30 | 0.25 |
| 93-04313-L1 | | Whole | 0.30 | 0.30 | 0.30 |

Table B2-9. Tank 241-B-111 Analytical Results: Barium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 34 | n/d | 34 |
| 93-04312a1 | | Whole | 32 | 31 | 32 |
| 93-04313a1 | | Whole | 29 | 31 | 30 |
| 93-04316a1 | Core 30 composite | Whole | 25 | 25 | 25 |
| 93-04317a1 | | Whole | 25 | n/d | 26 |
| 93-04317a1 | | Whole | 25 | 25 | 25 |
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 0.02 | n/d | 0.02 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 26 | < 27 | < 27 |
| 91-10553H-1T | | Upper half | < 24 | < 27 | < 26 |
| 92-04054H-1B | 30: 3 | Lower half | 56 | 36 | 46 |
| 92-04054H-1T | | Upper half | 38 | 33 | 36 |
| 92-04062H-1B | 30: 5 | Lower half | 43 | 44 | 44 |
| 92-04062H-1T | | Upper half | 52 | 42 | 47 |
| 93-4312h1 | Core 29 composite | Whole | 43 | 45 | 44 |
| 93-4313h1 | | Whole | 44 | 48 | 46 |
| 93-4316h1 | Core 30 composite | Whole | 37 | 53 | 45 |
| 93-4317h1 | | Whole | 33 | 35 | 34 |

Table B2-10. Tank 241-B-111 Analytical Results: Bismuth (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 19,100 | n/d | 19,100 |
| 93-04312a1 | | Whole | 19,900 | 19,500 | 19,700 |
| 93-04313a1 | | Whole | 18,200 | 19,200 | 18,700 |
| 93-04316a1 | Core 30 composite | Whole | 20,000 | 20,000 | 20,000 |
| 93-04317a1 | | Whole | 16,700 | n/d | 16,700 |
| 93-04317a1 | | Whole | 19,800 | 20,200 | 20,000 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 15,642 | 18,857 | 17,249.5 |
| 91-10553H-1T | | Upper half | 18,819 | 18,082 | 18,450.5 |
| 92-04054H-1B | 30: 3 | Lower half | 23,940 | 20,052 | 21,996 |
| 92-04054H-1T | | Upper half | 19,304 | 19,272 | 19,288 |
| 92-04062H-1B | 30: 5 | Lower half | 12,616 | 12,920 | 12,768 |
| 92-04062H-1T | | Upper half | 13,394 | 13,210 | 13,302 |
| 93-4312h1 | Core 29 composite | Whole | 20,580 | 20,001 | 20,290.5 |
| 93-4313h1 | | Whole | 19,968 | 20,189 | 20,078.5 |
| 93-4316h1 | Core 30 composite | Whole | 20,366 | 20,436 | 20,401 |
| 93-4317h1 | | Whole | 19,297 | 20,688 | 19,992.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 49 | 62 | 55.5 |
| 93-4313c1 | | Whole | 76 | 54 | 65 |
| 93-4316c1 | Core 30 composite | Whole | 76 | 54 | 65 |
| 93-4317c1 | | Whole | 68 | 68 | 68 |

Table B2-11. Tank 241-B-111 Analytical Results: Boron (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 59 | n/d | 59 |
| 93-04312a1 | | Whole | 54 | 59 | 56.5 |
| 93-04313a1 | | Whole | 41 | 48 | 44.5 |
| 93-04316a1 | Core 30 composite | Whole | 47 | 71 | 59 |
| 93-04317a1 | | Whole | 40 | n/d | 40 |
| 93-04317a1 | | Whole | 42 | 53 | 47.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 53 | 136 | < 94 |
| 91-10553H-1T | | Upper half | 82 | 107 | 94.5 |
| 92-04054H-1B | 30: 3 | Lower half | 248 | 126 | 187 |
| 92-04054H-1T | | Upper half | 133 | 82 | 107.5 |
| 92-04062H-1B | 30: 5 | Lower half | 165 | 137 | 151 |
| 92-04062H-1T | | Upper half | 212 | 128 | 170 |
| 93-4312h1 | Core 29 composite | Whole | 65 | 82 | 73.5 |
| 93-4313h1 | | Whole | 46 | 44 | 45 |
| 93-4316h1 | Core 30 composite | Whole | 66 | 186 | 126 |
| 93-4317h1 | | Whole | < 42 | 58 | < 50 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 21 | 12 | 16.5 |
| 93-4312c1 | | Whole | < 18 | n/d | < 18 |
| 93-4313c1 | | Whole | 17 | 10 | 13.5 |
| 93-4316c1 | Core 30 composite | Whole | 15 | 14 | 14.5 |
| 93-4317c1 | | Whole | 17 | 13 | 15 |

Table B2-12. Tank 241-B-111 Analytical Results: Cadmium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 2 | 2 | 2 |
| 93-04313a1 | | Whole | 3 | 3 | 3 |
| 93-04316a1 | Core 30 composite | Whole | 3 | 3 | 3 |
| 93-04317a1 | | Whole | 1 | 1 | 1 |
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 0.22 | 0.09 | 0.155 |
| 93-04313-L1 | | Whole | 0.07 | 0.07 | 0.07 |
| 93-04317-L1 | Core 30 composite | Whole | 0.03 | n/d | 0.03 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 30 | 29 | 29.5 |
| 91-10553H-1T | | Upper half | 28 | 34 | 31 |
| 92-04054H-1B | 30: 3 | Lower half | 20 | 18 | 19 |
| 92-04054H-1T | | Upper half | 26 | 22 | 24 |
| 92-04062H-1B | 30: 5 | Lower half | 19 | 18 | 18.5 |
| 92-04062H-1T | | Upper half | 21 | 16 | 18.5 |
| 93-4312h1 | Core 29 composite | Whole | 41 | 30 | 35.5 |
| 93-4313h1 | | Whole | 27 | 23 | 25 |
| 93-4316h1 | Core 30 composite | Whole | 14 | 14 | 14 |
| 93-4317h1 | | Whole | < 10 | 11 | < 11 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 0.9 | < 0.9 | < 0.9 |
| 93-4313c1 | | Whole | < 1 | < 0.8 | < 0.9 |
| 93-4316c1 | Core 30 composite | Whole | < 0.9 | < 0.7 | < 0.8 |
| 93-4317c1 | | Whole | < 0.9 | < 1 | < 1 |

Table B2-13. Tank 241-B-111 Analytical Results: Calcium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 572 | n/d | 572 |
| 93-04312a1 | | Whole | 544 | 527 | 535.5 |
| 93-04313a1 | | Whole | 492 | 525 | 508.5 |
| 93-04316a1 | Core 30 composite | Whole | 847 | 828 | 837.5 |
| 93-04317a1 | | Whole | 876 | n/d | 876 |
| 93-04317a1 | | Whole | 842 | 857 | 849.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 307 | 410 | 358.5 |
| 91-10553H-1T | | Upper half | 382 | 436 | 409 |
| 92-04054H-1B | 30: 3 | Lower half | 1,109 | 988 | 1,048.5 |
| 92-04054H-1T | | Upper half | 824 | 805 | 814.5 |
| 92-04062H-1B | 30: 5 | Lower half | 988 | 1,033 | 1,010.5 |
| 92-04062H-1T | | Upper half | 1,060 | 1,035 | 1,047.5 |
| 93-4312h1 | Core 29 composite | Whole | 808 | 735 | 771.5 |
| 93-4313h1 | | Whole | 708 | 734 | 721 |
| 93-4316h1 | Core 30 composite | Whole | 1,033 | 1,049 | 1,041 |
| 93-4317h1 | | Whole | 1,038 | 1,054 | 1,046 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 20 | 14 | 17 |
| 93-4313c1 | | Whole | 13 | 10 | 11.5 |
| 93-4316c1 | Core 30 composite | Whole | < 9 | 7 | < 8 |
| 93-4317c1 | | Whole | 9 | 10 | < 10 |

Table B2-14. Tank 241-B-111 Analytical Results: Cerium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 21 | 20 | 20.5 |
| 93-04313a1 | | Whole | 22 | 23 | 22.5 |
| 93-04316a1 | Core 30 composite | Whole | 22 | 27 | 24.5 |
| 93-04317a1 | | Whole | < 15 | < 16 | < 15 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 212 | < 217 | < 215 |
| 91-10553H-1T | | Upper half | < 192 | < 220 | < 206 |
| 92-04054H-1B | 30: 3 | Lower half | < 210 | < 191 | < 201 |
| 92-04054H-1T | | Upper half | < 204 | < 217 | < 210 |
| 92-04062H-1B | 30: 5 | Lower half | < 214 | < 216 | < 215 |
| 92-04062H-1T | | Upper half | < 213 | < 214 | < 214 |
| 93-4312h1 | Core 29 composite | Whole | < 158 | < 150 | < 154 |
| 93-4313h1 | | Whole | < 147 | < 149 | < 148 |
| 93-4316h1 | Core 30 composite | Whole | < 166 | < 162 | < 164 |
| 93-4317h1 | | Whole | < 167 | < 160 | < 163 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 15 | < 15 | < 15 |
| 93-4313c1 | | Whole | < 15 | < 12 | < 14 |
| 93-4316c1 | Core 30 composite | Whole | < 14 | < 12 | < 13 |
| 93-4317c1 | | Whole | < 15 | < 16 | < 15 |

Table B2-15. Tank 241-B-111 Analytical Results: Chromium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 1,119 | n/d | 1,119 |
| 93-04312a1 | | Whole | 1,089 | 1,062 | 1,075.5 |
| 93-04313a1 | | Whole | 991 | 1,051 | 1,021 |
| 93-04316a1 | Core 30 composite | Whole | 1,150 | 1,153 | 1,151.5 |
| 93-04317a1 | | Whole | 1,187 | n/d | 1,187 |
| 93-04317a1 | | Whole | 1,146 | 1,170 | 1,158 |
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 15.2 | 14.3 | 14.75 |
| 93-04313-L1 | | Whole | 14.5 | 14.9 | 14.7 |
| 93-04317-L1 | Core 30 composite | Whole | 12.2 | n/a | 12.2 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 923 | 1,105 | 1,014 |
| 91-10553H-1T | | Upper half | 1,101 | 1,056 | 1,078.5 |
| 92-04054H-1B | 30: 3 | Lower half | 1,360 | 1,172 | 1,266 |
| 92-04054H-1T | | Upper half | 1,036 | 1,029 | 1,032.5 |
| 92-04062H-1B | 30: 5 | Lower half | 898 | 912 | 905 |
| 92-04062H-1T | | Upper half | 924 | 930 | 927 |
| 93-4312h1 | Core 29 composite | Whole | 1,119 | 1,156 | 1,137.5 |
| 93-4313h1 | | Whole | 1,096 | 1,111 | 1,103.5 |
| 93-4316h1 | Core 30 composite | Whole | 1,178 | 1,183 | 1,180.5 |
| 93-4317h1 | | Whole | 1,130 | 1,193 | 1,161.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 298 | 301 | 299.5 |
| 93-4312c1 | | Whole | 305 | n/d | 305 |
| 93-4313c1 | | Whole | 303 | 298 | 300.5 |
| 93-4316c1 | Core 30 composite | Whole | 234 | 230 | 232 |
| 93-4317c1 | | Whole | 232 | 235 | 233.5 |

Table B2-16. Tank 241-B-111 Analytical Results: Cobalt (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 3 | 3 | 3 |
| 93-04313a1 | | Whole | 3 | 4 | 3.5 |
| 93-04316a1 | Core 30 composite | Whole | 4 | 4 | 4 |
| 93-04317a1 | | Whole | < 2 | < 2 | < 2 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 26 | < 27 | < 27 |
| 91-10553H-1T | | Upper half | < 24 | < 27 | < 26 |
| 92-04054H-1B | 30: 3 | Lower half | < 26 | < 24 | < 25 |
| 92-04054H-1T | | Upper half | < 25 | < 27 | < 26 |
| 92-04062H-1B | 30: 5 | Lower half | < 27 | < 27 | < 27 |
| 92-04062H-1T | | Upper half | < 27 | < 27 | < 27 |
| 93-4312h1 | Core 29 composite | Whole | 22 | 21 | 21.5 |
| 93-4313h1 | | Whole | 20 | 23 | 21.5 |
| 93-4316h1 | Core 30 composite | Whole | < 21 | 21 | < 21[QC:f] |
| 93-4317h1 | | Whole | 21 | < 20 | < 21[QC:f] |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 2 | < 2 | < 2 |
| 93-4313c1 | | Whole | < 2 | 2 | < 2 |
| 93-4316c1 | Core 30 composite | Whole | < 2 | < 1 | < 2 |
| 93-4317c1 | | Whole | < 2 | 2 | < 2 |

Table B2-17. Tank 241-B-111 Analytical Results: Copper (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| **Solids: acid digest** | | | **µg/g** | **µg/g** | **µg/g** |
| 93-04312a1 | Core 29 composite | Whole | 15 | n/d | 15[QC:f] |
| 93-04312a1 | | Whole | 11 | 10 | 11[QC:f] |
| 93-04313a1 | | Whole | 10 | 11 | 11[QC:f] |
| 93-04316a1 | Core 30 composite | Whole | 381 | 378 | 379.5 |
| 93-04317a1 | | Whole | 410 | n/d | 410 |
| 93-04317a1 | | Whole | 393 | 400 | 396.5 |
| **Solids: fusion digest** | | | **µg/g** | **µg/g** | **µg/g** |
| 91-10553H-1B | 29: 4 | Lower half | < 13 | < 14 | < 13 |
| 91-10553H-1T | | Upper half | < 12 | 17 | < 15 |
| 92-04054H-1B | 30: 3 | Lower half | 449 | 362 | 405.5 |
| 92-04054H-1T | | Upper half | 284 | 297 | 290.5 |
| 92-04062H-1B | 30: 5 | Lower half | 764 | 699 | 731.5 |
| 92-04062H-1T | | Upper half | 558 | 567 | 562.5 |
| 93-4312h1 | Core 29 composite | Whole | 37 | 34 | 35.5 |
| 93-4313h1 | | Whole | 35 | 40 | 37.5 |
| 93-4316h1 | Core 30 composite | Whole | 402 | 403 | 402.5 |
| 93-4317h1 | | Whole | 399 | 418 | 408.5 |
| **Solids: water digest** | | | **µg/g** | **µg/g** | **µg/g** |
| 93-4312c1 | Core 29 composite | Whole | < 0.9 | < 0.9 | < 0.9 |
| 93-4313c1 | | Whole | < 1 | 1 | < 1 |
| 93-4316c1 | Core 30 composite | Whole | 9 | 8 | 8.5 |
| 93-4317c1 | | Whole | 10 | 10 | 10 |

Table B2-18. Tank 241-B-111 Analytical Results: Iron (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 16,446 | n/d | 16,446 |
| 93-04312a1 | | Whole | 15,922 | 15,581 | 15,751.5 |
| 93-04313a1 | | Whole | 14,561 | 15,309 | 14,935 |
| 93-04316a1 | Core 30 composite | Whole | 17,136 | 17,138 | 17,137 |
| 93-04317a1 | | Whole | 18,001 | n/d | 18,001 |
| 93-04317a1 | | Whole | 17,232 | 17,442 | 17,337 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 12,213 | 14,760 | 13,486.5 |
| 91-10553H-1T | | Upper half | 14,567 | 14,063 | 14,315 |
| 92-04054H-1B | 30: 3 | Lower half | 20,501 | 17,682 | 19,091.5 |
| 92-04054H-1T | | Upper half | 16,054 | 16,054 | 16,054 |
| 92-04062H-1B | 30: 5 | Lower half | 12,525 | 12,867 | 12,696 |
| 92-04062H-1T | | Upper half | 12,996 | 13,199 | 13,097.5 |
| 93-4312h1 | Core 29 composite | Whole | 16,891 | 16,848 | 16,869.5 |
| 93-4313h1 | | Whole | 16,660 | 17,136 | 16,898 |
| 93-4316h1 | Core 30 composite | Whole | 18,828 | 18,753 | 18,790.5 |
| 93-4317h1 | | Whole | 17,952 | 18,683 | 18,317.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 70 | 91 | 80.5 |
| 93-4312c1 | | Whole | 67 | n/d | 67 |
| 93-4313c1 | | Whole | 99 | 65 | 82 |
| 93-4316c1 | Core 30 composite | Whole | 87 | 73 | 80 |
| 93-4317c1 | | Whole | 82 | 86 | 84 |

Table B2-19. Tank 241-B-111 Analytical Results: Lanthanum (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 7 | 7 | 7 |
| 93-04313a1 | | Whole | 7 | 8 | 7.5 |
| 93-04316a1 | Core 30 composite | Whole | 6 | 8 | 7 |
| 93-04317a1 | | Whole | < 6 | < 6 | < 6 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 79 | < 82 | < 80 |
| 91-10553H-1T | | Upper half | < 72 | < 82 | < 77 |
| 92-04054H-1B | 30: 3 | Lower half | < 79 | < 72 | < 75 |
| 92-04054H-1T | | Upper half | < 76 | < 81 | < 89 |
| 92-04062H-1B | 30: 5 | Lower half | < 80 | < 81 | < 81 |
| 92-04062H-1T | | Upper half | < 80 | < 80 | < 80 |
| 93-4312h1 | Core 29 composite | Whole | < 59 | < 56 | < 58 |
| 93-4313h1 | | Whole | < 55 | < 56 | < 56 |
| 93-4316h1 | Core 30 composite | Whole | < 62 | < 61 | < 61 |
| 93-4317h1 | | Whole | < 63 | < 60 | < 61 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 5.5 | < 5.7 | < 5.6 |
| 93-4313c1 | | Whole | < 5.8 | < 4.6 | < 5.2 |
| 93-4316c1 | Core 30 composite | Whole | < 5.4 | < 4.4 | < 4.9 |
| 93-4317c1 | | Whole | < 5.7 | < 5.8 | < 5.8 |

Table B2-20. Tank 241-B-111 Analytical Results: Lead (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 1,569 | n/d | 1,569 |
| 93-04312a1 | | Whole | 1,477 | 1,436 | 1,456.5 |
| 93-04313a1 | | Whole | 1,371 | 1,453 | 1,412 |
| 93-04316a1 | Core 30 composite | Whole | 1,665 | 1,678 | 1,671.5 |
| 93-04317a1 | | Whole | 1,726 | n/d | 1,726 |
| 93-04317a1 | | Whole | 1,666 | 1,688 | 1,677 |
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 0.54 | 0.65 | 0.595 |
| 93-04313-L1 | | Whole | 0.3 | 0.3 | 0.3 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 215 | 224 | 219.5 |
| 91-10553H-1T | | Upper half | 192 | 302 | 247 |
| 92-04054H-1B | 30: 3 | Lower half | 1,868 | 1,563 | 1,715.5 |
| 92-04054H-1T | | Upper half | 1,277 | 1,262 | 1,269.5 |
| 92-04062H-1B | 30: 5 | Lower half | 2,242 | 2,319 | 2,280.5 |
| 92-04062H-1T | | Upper half | 2,318 | 2,307 | 2,312.5 |
| 93-4312h1 | Core 29 composite | Whole | 1,899 | 1,804 | 1,851.5 |
| 93-4313h1 | | Whole | 1,740 | 1,791 | 1,765.5 |
| 93-4316h1 | Core 30 composite | Whole | 1,875 | 1,915 | 1,895 |
| 93-4317h1 | | Whole | 1,821 | 1,927 | 1,874 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 11 | < 11 | < 11 |
| 93-4313c1 | | Whole | < 12 | 10 | < 11 |
| 93-4316c1 | Core 30 composite | Whole | 11 | < 9 | < 10 |
| 93-4317c1 | | Whole | < 11 | 12 | < 12 |

Table B2-21. Tank 241-B-111 Analytical Results: Magnesium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 219 | n/d | 219 |
| 93-04312a1 | | Whole | 196 | 194 | 195 |
| 93-04313a1 | | Whole | 180 | 192 | 186 |
| 93-04316a1 | Core 30 composite | Whole | 201 | 199 | 200 |
| 93-04317a1 | | Whole | 196 | n/d | 196 |
| 93-04317a1 | | Whole | 188 | 191 | 189.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 92-04054H-1B | 30: 3 | Lower half | 288 | 284 | 286 |
| 92-04054H-1T | | Upper half | 210 | 230 | 220 |
| 92-04062H-1B | 30: 5 | Lower half | 324 | 388 | 356 |
| 92-04062H-1T | | Upper half | 294 | 353 | 323.5 |
| 93-4312h1 | Core 29 composite | Whole | 307 | 304 | 305.5 |
| 93-4313h1 | | Whole | 297 | 315 | 306 |
| 93-4316h1 | Core 30 composite | Whole | 360 | 371 | 365.5 |
| 93-4317h1 | | Whole | 354 | 364 | 359 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 14 | < 15 | < 15 |
| 93-4313c1 | | Whole | < 15 | < 12 | < 14 |
| 93-4316c1 | Core 30 composite | Whole | < 14 | < 12 | < 13 |
| 93-4317c1 | | Whole | < 15 | 20 | < 18 |

Table B2-22. Tank 241-B-111 Analytical Results: Manganese (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 88 | n/d | 88 |
| 93-04312a1 | | Whole | 86 | 84 | 85 |
| 93-04313a1 | | Whole | 79 | 83 | 81 |
| 93-04316a1 | Core 30 composite | Whole | 74 | 73 | 73.5 |
| 93-04317a1 | | Whole | 76 | n/d | 76 |
| 93-04317a1 | | Whole | 74 | 75 | 74.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 47 | 55 | 51 |
| 91-10553H-1T | | Upper half | 54 | 55 | 54.5 |
| 92-04054H-1B | 30: 3 | Lower half | 104 | 93 | 98.5 |
| 92-04054H-1T | | Upper half | 81 | 81 | 81 |
| 92-04062H-1B | 30: 5 | Lower half | 94 | 92 | 93 |
| 92-04062H-1T | | Upper half | 83 | 86 | 84.5 |
| 93-4312h1 | Core 29 composite | Whole | 107 | 121 | 114 |
| 93-4313h1 | | Whole | 105 | 112 | 108.5 |
| 93-4316h1 | Core 30 composite | Whole | 111 | 109 | 110 |
| 93-4317h1 | | Whole | 118 | 103 | 110.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 0.9 | < 0.9 | < 0.9 |
| 93-4313c1 | | Whole | < 1 | < 0.8 | < 0.9 |
| 93-4316c1 | Core 30 composite | Whole | < 0.9 | < 0.7 | < 0.8 |
| 93-4317c1 | | Whole | < 0.9 | < 1 | < 1 |

Table B2-23. Tank 241-B-111 Analytical Results: Molybdenum (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 51 | n/d | 51 |
| 93-04312a1 | | Whole | 46 | 45 | 45.5 |
| 93-04313a1 | | Whole | 42 | 45 | 43.5 |
| 93-04316a1 | Core 30 composite | Whole | 39 | 40 | 39.5 |
| 93-04317a1 | | Whole | 35 | n/d | 35 |
| 93-04317a1 | | Whole | 37 | 37 | 37 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 53 | < 54 | < 54 |
| 91-10553H-1T | | Upper half | < 48 | < 55 | < 51 |
| 92-04054H-1B | 30: 3 | Lower half | < 53 | < 48 | < 50 |
| 92-04054H-1T | | Upper half | < 51 | < 54 | < 53 |
| 92-04062H-1B | 30: 5 | Lower half | < 53 | < 54 | < 54 |
| 92-04062H-1T | | Upper half | < 53 | < 54 | < 53 |
| 93-4312h1 | Core 29 composite | Whole | 58 | 58 | 58 |
| 93-4313h1 | | Whole | 57 | 56 | 56.5 |
| 93-4316h1 | Core 30 composite | Whole | 50 | 53 | 51.5 |
| 93-4317h1 | | Whole | 53 | 49 | 51 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 40 | 40 | 40 |
| 93-4312c1 | | Whole | 41 | n/d | 41 |
| 93-4313c1 | | Whole | 40 | 40 | 40 |
| 93-4316c1 | Core 30 composite | Whole | 33 | 32 | 32.5 |
| 93-4317c1 | | Whole | 33 | 35 | 34 |

Table B2-24. Tank 241-B-111 Analytical Results: Neodymium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| **Solids: acid digest** | | | **µg/g** | **µg/g** | **µg/g** |
| 93-04312a1 | Core 29 composite | Whole | 54 | n/d | 54 |
| 93-04312a1 | | Whole | 18 | 18 | 18 |
| 93-04313a1 | | Whole | 22 | 24 | 23 |
| 93-04316a1 | Core 30 composite | Whole | 18 | 24 | 21 |
| 93-04317a1 | | Whole | 7 | 8 | 7.5 |
| **Solids: fusion digest** | | | **µg/g** | **µg/g** | **µg/g** |
| 91-10553H-1B | 29: 4 | Lower half | < 79 | < 82 | < 80 |
| 91-10553H-1T | | Upper half | < 72 | < 82 | < 77 |
| 92-04054H-1B | 30: 3 | Lower half | < 79 | < 72 | < 75 |
| 92-04054H-1T | | Upper half | < 76 | < 81 | < 79 |
| 92-04062H-1B | 30: 5 | Lower half | < 80 | < 81 | < 81 |
| 92-04062H-1T | | Upper half | < 80 | < 80 | < 80 |
| 93-4312h1 | Core 29 composite | Whole | 105 | 90 | 97.5 |
| 93-4313h1 | | Whole | 88 | 112 | 100 |
| 93-4316h1 | Core 30 composite | Whole | 75 | 93 | 84 |
| 93-4317h1 | | Whole | 100 | 91 | 95.5 |
| **Solids: water digest** | | | **µg/g** | **µg/g** | **µg/g** |
| 93-4312c1 | Core 29 composite | Whole | < 6 | < 6 | < 6 |
| 93-4313c1 | | Whole | < 6 | 7 | < 6 |
| 93-4316c1 | Core 30 composite | Whole | 5 | < 4 | < 5 |
| 93-4317c1 | | Whole | 6 | 7 | 6.5 |

Table B2-25. Tank 241-B-111 Analytical Results: Nickel (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 19 | 19 | 19 |
| 93-04313a1 | | Whole | 18 | 20 | 19 |
| 93-04316a1 | Core 30 composite | Whole | 19 | 20 | 19.5 |
| 93-04317a1 | | Whole | 17 | 17 | 17 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 6 | < 6 | < 6 |
| 93-4313c1 | | Whole | < 6 | < 5 | < 6 |
| 93-4316c1 | Core 30 composite | Whole | < 5 | < 4 | < 5 |
| 93-4317c1 | | Whole | < 6 | 7 | < 6 |

Table B2-26. Tank 241-B-111 Analytical Results: Palladium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | < 30 | < 28 | < 29 |
| 93-04313a1 | | Whole | < 28 | < 27 | < 28 |
| 93-04316a1 | Core 30 composite | Whole | < 30 | 32 | < 31 |
| 93-04317a1 | | Whole | < 28 | < 29 | < 29 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 370 | < 408 | < 402 |
| 91-10553H-1T | | Upper half | < 360 | < 412 | < 386 |
| 92-04054H-1B | 30: 3 | Lower half | < 395 | < 358 | < 377 |
| 92-04054H-1T | | Upper half | < 382 | < 408 | < 394 |
| 92-04062H-1B | 30: 5 | Lower half | < 401 | < 404 | < 403 |
| 92-04062H-1T | | Upper half | < 400 | < 402 | < 401 |
| 93-4312h1 | Core 29 composite | Whole | < 297 | < 282 | < 289 |
| 93-4313h1 | | Whole | < 276 | 306 | < 291 |
| 93-4316h1 | Core 30 composite | Whole | < 310 | < 304 | < 307 |
| 93-4317h1 | | Whole | < 313 | < 300 | < 307 |

Table B2-27. Tank 241-B-111 Analytical Results: Phosphorus (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 14,314 | n/d | 14,314 |
| 93-04312a1 | | Whole | 13,999 | 14,043 | 14,021 |
| 93-04313a1 | | Whole | 12,959 | 13,765 | 13,362 |
| 93-04316a1 | Core 30 composite | Whole | 16,898 | 16,737 | 16,817.5 |
| 93-04317a1 | | Whole | 17,042 | n/d | 17,042 |
| 93-04317a1 | | Whole | 16,430 | 16,710 | 16,570 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 13,673 | 16,433 | 15,053 |
| 91-10553H-1T | | Upper half | 16,154 | 15,527 | 15,840.5 |
| 92-04054H-1B | 30: 3 | Lower half | 20,935 | 18,141 | 19,538 |
| 92-04054H-1T | | Upper half | 15,901 | 15,875 | 15,888 |
| 92-04062H-1B | 30: 5 | Lower half | 13,578 | 13,867 | 13,722.5 |
| 92-04062H-1T | | Upper half | 14,271 | 14,417 | 14,344 |
| 93-4312h1 | Core 29 composite | Whole | 14,855 | 14,589 | 14,722 |
| 93-4313h1 | | Whole | 14,534 | 14,520 | 14,527 |
| 93-4316h1 | Core 30 composite | Whole | 17,380 | 17,432 | 17,406 |
| 93-4317h1 | | Whole | 16,589 | 17,547 | 17,068 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 7,102 | 7,165 | 7,133.5 |
| 93-4312c1 | | Whole | 7,099 | n/d | 7,099 |
| 93-4313c1 | | Whole | 7,355 | 7,230 | 7,292.5 |
| 93-4316c1 | Core 30 composite | Whole | 7,818 | 7,633 | 7,725.5 |
| 93-4317c1 | | Whole | 7,933 | 7,918 | 7,925.5 |

Table B2-28. Tank 241-B-111 Analytical Results: Potassium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 1,578 | n/d | 1,578 |
| 93-04312a1 | | Whole | 499 | 493 | 496 |
| 93-04313a1 | | Whole | 590 | 663 | 626.5 |
| 93-04316a1 | Core 30 composite | Whole | 602 | 773 | 687.5 |
| 93-04317a1 | | Whole | 289 | 304 | 296.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 586 | 623 | 604.5 |
| 93-4313c1 | | Whole | 600 | 698 | 649 |
| 93-4316c1 | Core 30 composite | Whole | 564 | 477 | 520.5 |
| 93-4317c1 | | Whole | 566 | 592 | 579 |

Table B2-29. Tank 241-B-111 Analytical Results: Selenium (ICP). (2 sheets)

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 20 | 19 | 19.5 |
| 93-04313a1 | | Whole | 25 | 25 | 25 |
| 93-04316a1 | Core 30 composite | Whole | 27 | 32 | 29.5 |
| 93-04317a1 | | Whole | < 14 | < 15 | < 14 |
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 0.2 | 0.2 | 0.2 |
| 93-04313-L1 | | Whole | n/a | 0.2 | 0.2 |

Table B2-29. Tank 241-B-111 Analytical Results: Selenium (ICP). (2 sheets)

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| **Solids: fusion digest** | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 198 | < 204 | < 201 |
| 91-10553H-1T | | Upper half | < 180 | < 206 | < 193 |
| 92-04054H-1B | 30: 3 | Lower half | < 197 | < 179 | < 188 |
| 92-04054H-1T | | Upper half | < 191 | < 203 | < 197 |
| 92-04062H-1B | 30: 5 | Lower half | < 201 | < 202 | < 201 |
| 92-04062H-1T | | Upper half | < 200 | < 201 | < 200 |
| 93-4312h1 | Core 29 composite | Whole | < 148 | < 141 | < 145 |
| 93-4313h1 | | Whole | < 138 | < 140 | < 139 |
| 93-4316h1 | Core 30 composite | Whole | < 155 | < 152 | < 154 |
| 93-4317h1 | | Whole | < 156 | < 150 | < 153 |
| **Solids: water digest** | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 14 | < 14 | < 14 |
| 93-4313c1 | | Whole | < 14 | < 11 | < 13 |
| 93-4316c1 | Core 30 composite | Whole | < 13 | < 11 | < 12 |
| 93-4317c1 | | Whole | < 14 | < 15 | < 14 |

Table B2-30. Tank 241-B-111 Analytical Results: Silicon (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 617 | n/d | 617 |
| 93-04312a1 | | Whole | 589 | 559 | 574 |
| 93-04313a1 | | Whole | 605 | 607 | 606 |
| 93-04316a1 | Core 30 composite | Whole | 417 | 351 | 384[QC:c] |
| 93-04317a1 | | Whole | 399 | n/d | 399 |
| 93-04317a1 | | Whole | 397 | 370 | 383.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 2,874 | 3,684 | 3,279 |
| 91-10553H-1T | | Upper half | 3,383 | 3,407 | 3,395 |
| 92-04054H-1B | 30: 3 | Lower half | 5,945 | 5,113 | 5,529 |
| 92-04054H-1T | | Upper half | 5,795 | 5,490 | 5,642.5 |
| 92-04062H-1B | 30: 5 | Lower half | 6,785 | 6,893 | 6,839 |
| 92-04062H-1T | | Upper half | 4,791 | 5,242 | 5,016.5 |
| 93-4312h1 | Core 29 composite | Whole | 9,497 | 9,452 | 9,474.5 |
| 93-4313h1 | | Whole | 9,365 | 9,612 | 9,488.5 |
| 93-4316h1 | Core 30 composite | Whole | 11,183 | 11,341 | 11,262 |
| 93-4317h1 | | Whole | 10,987 | 11,420 | 11,203.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 632 | 644 | 638 |
| 93-4312c1 | | Whole | 631 | n/d | 631 |
| 93-4313c1 | | Whole | 699 | 642 | 670.5 |
| 93-4316c1 | Core 30 composite | Whole | 636 | 598 | 617 |
| 93-4317c1 | | Whole | 705 | 677 | 691 |

Table B2-31. Tank 241-B-111 Analytical Results: Silver (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 2 | 2 | 2 |
| 93-04313a1 | | Whole | 4 | 4 | 4 |
| 93-04316a1 | Core 30 composite | Whole | 9 | 9 | 9 |
| 93-04317a1 | | Whole | 5 | 5 | 5 |
| Solids: TCLP | | | µg/mL | µg/mL | µg/mL |
| 93-04312-L1 | Core 29 composite | Whole | 0.03 | 0.03 | 0.03[QC:c] |
| 93-04313-L1 | | Whole | 0.04 | 0.04 | **0.04** |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 26 | < 27 | < 27 |
| 91-10553H-1T | | Upper half | < 24 | < 27 | < 26 |
| 92-04054H-1B | 30: 3 | Lower half | 32 | 34 | 33 |
| 92-04054H-1T | | Upper half | < 25 | 28 | < 27 |
| 92-04062H-1B | 30: 5 | Lower half | 42 | 40 | 41 |
| 92-04062H-1T | | Upper half | 36 | 50 | 43 |
| 93-4312h1 | Core 29 composite | Whole | 145 | 129 | 137 |
| 93-4313h1 | | Whole | 116 | 125 | 120.5 |
| 93-4316h1 | Core 30 composite | Whole | 76 | 72 | 74 |
| 93-4317h1 | | Whole | 60 | 56 | 58 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 2 | < 2 | < 2 |
| 93-4313c1 | | Whole | < 2 | 2 | < 2 |
| 93-4316c1 | Core 30 composite | Whole | < 2 | < 1 | < 2 |
| 93-4317c1 | | Whole | < 2 | < 2 | < 2 |

Table B2-32. Tank 241-B-111 Analytical Results: Sodium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 90,178 | n/d | 90,178 |
| 93-04312a1 | | Whole | 88,236 | 87,315 | 87,775.5 |
| 93-04313a1 | | Whole | 80,354 | 85,503 | 82,928.5 |
| 93-04316a1 | Core 30 composite | Whole | 89,897 | 88,672 | 89,284.5 |
| 93-04317a1 | | Whole | 91,987 | n/d | 91,987 |
| 93-04317a1 | | Whole | 88,940 | 90,710 | 89,825 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 78,224 | 94,786 | 86,505 |
| 91-10553H-1T | | Upper half | 94,023 | 90,289 | 92,156 |
| 92-04054H-1B | 30: 3 | Lower half | 1.168E+05 | 1.007E+05 | 1.087E+05 |
| 92-04054H-1T | | Upper half | 84,791 | 84,540 | 84,665.5 |
| 92-04062H-1B | 30: 5 | Lower half | 79,505 | 79,011 | 79,258 |
| 92-04062H-1T | | Upper half | 83,626 | 82,005 | 82,815.5 |
| 93-4312h1 | Core 29 composite | Whole | 1.010E+05 | 97,753 | 99,397.5 |
| 93-4313h1 | | Whole | 96,341 | 94,872 | 95,606.5 |
| 93-4316h1 | Core 30 composite | Whole | 94,845 | 94,963 | 94,904 |
| 93-4317h1 | | Whole | 90,676 | 95,236 | 92,956 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 80,647 | 80,435 | 80,541 |
| 93-4312c1 | | Whole | 81,389 | n/d | 81,389 |
| 93-4313c1 | | Whole | 80,864 | 79,476 | 80,170 |
| 93-4316c1 | Core 30 composite | Whole | 80,248 | 79,111 | 79,679.5 |
| 93-4317c1 | | Whole | 80,706 | 81,656 | 81,181 |

Table B2-33. Tank 241-B-111 Analytical Results: Strontium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 226 | n/d | 226 |
| 93-04312a1 | | Whole | 223 | 218 | 220.5 |
| 93-04313a1 | | Whole | 203 | 215 | 209 |
| 93-04316a1 | Core 30 composite | Whole | 217 | 215 | 216 |
| 93-04317a1 | | Whole | 227 | n/d | 227 |
| 93-04317a1 | | Whole | 220 | 225 | 222.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | 162 | 197 | 179.5 |
| 91-10553H-1T | | Upper half | 194 | 188 | 191 |
| 92-04054H-1B | 30: 3 | Lower half | 256 | 227 | 241.5 |
| 92-04054H-1T | | Upper half | 203 | 203 | 203 |
| 92-04062H-1B | 30: 5 | Lower half | 151 | 153 | 152 |
| 92-04062H-1T | | Upper half | 157 | 156 | 156.5 |
| 93-4312h1 | Core 29 composite | Whole | 228 | 223 | 225.5 |
| 93-4313h1 | | Whole | 223 | 226 | 224.5 |
| 93-4316h1 | Core 30 composite | Whole | 219 | 219 | 219 |
| 93-4317h1 | | Whole | 209 | 222 | 215.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 1 | 1 | 1 |
| 93-4313c1 | | Whole | 1 | 1 | 1 |
| 93-4316c1 | Core 30 composite | Whole | 1 | 1 | 1 |
| 93-4317c1 | | Whole | < 1 | < 1 | < 1 |

Table B2-34. Tank 241-B-111 Analytical Results: Tellurium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | < 20 | < 19 | < 19 |
| 93-04313a1 | | Whole | 19 | 21 | 20 |
| 93-04316a1 | Core 30 composite | Whole | 23 | 25 | 24 |
| 93-04317a1 | | Whole | < 19 | < 20 | < 19 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 265 | < 272 | < 269 |
| 91-10553H-1T | | Upper half | < 240 | < 275 | < 258 |
| 92-04054H-1B | 30: 3 | Lower half | < 263 | < 239 | < 251 |
| 92-04054H-1T | | Upper half | < 255 | < 271 | < 263 |
| 92-04062H-1B | 30: 5 | Lower half | < 267 | < 270 | < 269 |
| 92-04062H-1T | | Upper half | < 267 | < 268 | < 268 |
| 93-4312h1 | Core 29 composite | Whole | < 198 | < 189 | < 194 |
| 93-4313h1 | | Whole | < 184 | < 186 | < 185 |
| 93-4316h1 | Core 30 composite | Whole | < 207 | < 203 | < 205 |
| 93-4317h1 | | Whole | < 209 | < 200 | < 205 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | 1 | 1 | 1 |
| 93-4313c1 | | Whole | 1 | 1 | 1 |
| 93-4316c1 | Core 30 composite | Whole | 1 | 1 | 1 |
| 93-4317c1 | | Whole | < 1 | < 1 | < 1 |

Table B2-35. Tank 241-B-111 Analytical Results: Titanium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 10 | n/d | 10 |
| 93-04312a1 | | Whole | 8 | 9 | 8.5 |
| 93-04313a1 | | Whole | 9 | 9 | 9 |
| 93-04316a1 | Core 30 composite | Whole | 7 | 7 | 7 |
| 93-04317a1 | | Whole | 8 | n/d | 8 |
| 93-04317a1 | | Whole | 6 | 6 | 6 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 13 | < 14 | < 13 |
| 91-10553H-1T | | Upper half | < 12 | < 14 | < 13 |
| 92-04054H-1B | 30: 3 | Lower half | 23 | 20 | 21.5 |
| 92-04054H-1T | | Upper half | 19 | 17 | 18 |
| 92-04062H-1B | 30: 5 | Lower half | 29 | 33 | 31 |
| 92-04062H-1T | | Upper half | 31 | 36 | 33.5 |
| 93-4312h1 | Core 29 composite | Whole | 29 | 28 | 28.5 |
| 93-4313h1 | | Whole | 25 | 28 | 26.5 |
| 93-4316h1 | Core 30 composite | Whole | 31 | 29 | 30 |
| 93-4317h1 | | Whole | 30 | 29 | 29.5 |

Table B2-36. Tank 241-B-111 Analytical Results: Total Uranium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 229 | 221 | 225 |
| 93-04313a1 | | Whole | 301 | 323 | 312 |
| 93-04316a1 | Core 30 composite | Whole | 317 | 408 | 362.5 |
| 93-04317a1 | | Whole | < 190 | < 196 | < 193 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 2,600 | < 2,700 | < 2,700 |
| 91-10553H-1T | | Upper half | < 2,400 | < 2,700 | < 2,600 |
| 92-04054H-1B | 30: 3 | Lower half | < 2,600 | < 2,400 | < 2,500 |
| 92-04054H-1T | | Upper half | < 2,500 | < 2,700 | < 2,600 |
| 92-04062H-1B | 30: 5 | Lower half | < 2,700 | < 2,700 | < 2,700 |
| 92-04062H-1T | | Upper half | < 2,700 | < 2,700 | < 2,700 |
| 93-4312h1 | Core 29 composite | Whole | < 2,000 | < 1,900 | < 1,900 |
| 93-4313h1 | | Whole | < 1,800 | < 1,900 | < 1,900 |
| 93-4316h1 | Core 30 composite | Whole | < 2,100 | < 2,000 | < 2,000 |
| 93-4317h1 | | Whole | < 2,100 | < 2,000 | < 2,000 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 183 | 196 | < 190 |
| 93-4313c1 | | Whole | < 192 | 226 | < 209 |
| 93-4316c1 | Core 30 composite | Whole | 187 | 164 | 175.5 |
| 93-4317c1 | | Whole | < 189 | 200 | < 195 |

Table B2-37. Tank 241-B-111 Analytical Results: Vanadium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 2 | 2 | 2 |
| 93-04313a1 | | Whole | 3 | 3 | 3 |
| 93-04316a1 | Core 30 composite | Whole | 3 | 3 | 3 |
| 93-04317a1 | | Whole | < 2 | < 2 | < 2 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 26 | < 27 | < 27 |
| 91-10553H-1T | | Upper half | < 24 | < 27 | < 26 |
| 92-04054H-1B | 30: 3 | Lower half | < 26 | < 24 | < 25 |
| 92-04054H-1T | | Upper half | < 25 | < 27 | < 26 |
| 92-04062H-1B | 30: 5 | Lower half | < 27 | < 27 | < 27 |
| 92-04062H-1T | | Upper half | < 27 | < 27 | < 27 |
| 93-4312h1 | Core 29 composite | Whole | < 20 | < 19 | < 19 |
| 93-4313h1 | | Whole | < 18 | < 19 | < 19 |
| 93-4316h1 | Core 30 composite | Whole | < 21 | < 20 | < 20 |
| 93-4317h1 | | Whole | < 21 | < 20 | < 20 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 2 | < 2 | < 2 |
| 93-4313c1 | | Whole | < 2 | < 2 | < 2 |
| 93-4316c1 | Core 30 composite | Whole | < 2 | < 2 | < 2 |
| 93-4317c1 | | Whole | < 2 | < 2 | < 2 |

Table B2-38. Tank 241-B-111 Analytical Results: Yttrium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 3 | 3 | 3 |
| 93-04313a1 | | Whole | 3 | 3 | 3 |
| 93-04316a1 | Core 30 composite | Whole | < 2 | 2 | < 2 |
| 93-04317a1 | | Whole | < 2 | < 2 | < 2 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 26 | < 27 | < 27 |
| 91-10553H-1T | | Upper half | < 24 | < 27 | < 26 |
| 92-04054H-1B | 30: 3 | Lower half | < 26 | < 24 | < 25 |
| 92-04054H-1T | | Upper half | < 25 | < 27 | < 26 |
| 92-04062H-1B | 30: 5 | Lower half | < 27 | < 27 | < 27 |
| 92-04062H-1T | | Upper half | < 27 | < 27 | < 27 |
| 93-4312h1 | Core 29 composite | Whole | < 20 | < 19 | < 19 |
| 93-4313h1 | | Whole | < 18 | < 19 | < 19 |
| 93-4316h1 | Core 30 composite | Whole | < 21 | < 20 | < 20 |
| 93-4317h1 | | Whole | < 21 | < 20 | < 20 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 2 | < 2 | < 2 |
| 93-4313c1 | | Whole | < 2 | < 2 | < 2 |
| 93-4316c1 | Core 30 composite | Whole | < 2 | < 2 | < 2 |
| 93-4317c1 | | Whole | < 2 | < 2 | < 2 |

Table B2-39. Tank 241-B-111 Analytical Results: Zinc (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 58 | n/d | 58 |
| 93-04312a1 | | Whole | 57 | 56 | 56.5 |
| 93-04313a1 | | Whole | 52 | 55 | 53.5 |
| 93-04316a1 | Core 30 composite | Whole | 163 | 162 | 162.5 |
| 93-04317a1 | | Whole | 174 | n/d | 174 |
| 93-04317a1 | | Whole | 164 | 169 | 166.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 53 | < 54 | < 54 |
| 91-10553H-1T | | Upper half | < 48 | < 55 | < 51 |
| 92-04054H-1B | 30: 3 | Lower half | 166 | 141 | 153.5 |
| 92-04054H-1T | | Upper half | 92 | 97 | 94.5 |
| 92-04062H-1B | 30: 5 | Lower half | 291 | 298 | 294.5 |
| 92-04062H-1T | | Upper half | 295 | 300 | 297.5 |
| 93-4312h1 | Core 29 composite | Whole | 151 | 129 | 140 |
| 93-4313h1 | | Whole | 124 | 127 | 125.5 |
| 93-4316h1 | Core 30 composite | Whole | 215 | 215 | 215 |
| 93-4317h1 | | Whole | 211 | 212 | 211.5 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 4 | < 4 | < 4 |
| 93-4313c1 | | Whole | < 4 | < 4 | < 4 |
| 93-4316c1 | Core 30 composite | Whole | < 4 | < 4 | < 4 |
| 93-4317c1 | | Whole | < 4 | < 4 | < 4 |

Table B2-40. Tank 241-B-111 Analytical Results: Zirconium (ICP).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: acid digest | | | µg/g | µg/g | µg/g |
| 93-04312a1 | Core 29 composite | Whole | 22 | n/d | 22 |
| 93-04312a1 | | Whole | 18 | 18 | 18 |
| 93-04313a1 | | Whole | 17 | 18 | 17.5 |
| 93-04316a1 | Core 30 composite | Whole | 10 | 11 | 10.5 |
| 93-04317a1 | | Whole | 11 | n/d | 11 |
| 93-04317a1 | | Whole | 9 | 10 | 9.5 |
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 91-10553H-1B | 29: 4 | Lower half | < 26 | < 27 | < 27 |
| 91-10553H-1T | | Upper half | < 24 | < 27 | < 26 |
| 92-04054H-1B | 30: 3 | Lower half | < 26 | < 24 | < 25 |
| 92-04054H-1T | | Upper half | < 25 | < 27 | < 26 |
| 92-04062H-1B | 30: 5 | Lower half | < 27 | < 27 | < 27 |
| 92-04062H-1T | | Upper half | < 27 | < 27 | < 27 |
| 93-4312h1 | Core 29 composite | Whole | 22 | 19 | 21 |
| 93-4313h1 | | Whole | 19 | 22 | 21 |
| 93-4316h1 | Core 30 composite | Whole | < 21 | < 20 | < 20 |
| 93-4317h1 | | Whole | < 21 | < 20 | < 20 |
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-4312c1 | Core 29 composite | Whole | < 2 | < 2 | < 2 |
| 93-4313c1 | | Whole | < 2 | < 2 | < 2 |
| 93-4316c1 | Core 30 composite | Whole | < 2 | < 2 | < 2 |
| 93-4317c1 | | Whole | < 2 | < 2 | < 2 |

Table B2-41. Tank 241-B-111 Analytical Results: Hexavalent Chromium (Colorimetric).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 187 | 182 | 184.5 |
| 93-04313-C | | Whole | 162 | 152 | 157 |
| 93-04316-C | Core 30 composite | Whole | 140 | 143 | 141.5 |
| 93-04317-C | | Whole | 165 | 158 | 161.5 |

Table B2-42. Tank 241-B-111 Analytical Results: Total Uranium (LF).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µg/g | µg/g | µg/g |
| 93-04312-H-1 | Core 29 composite | Whole | 207 | 204 | 205.5 |
| 93-04313-H-1 | | Whole | 204 | 208 | 206 |
| 93-04316-H-1 | Core 30 composite | Whole | 188 | 184 | 186 |
| 93-04317-H-1 | | Whole | 189 | 195 | 192 |

Table B2-43. Tank 241-B-111 Analytical Results: Cyanide (CN).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 2.7 | 3.1 | 2.9 |
| 93-04313-C | | Whole | 2.6 | < 0.4 | < 1.5[QC:d] |
| 93-04316-C | Core 30 composite | Whole | 1.6 | 2.0 | 1.8 |
| 93-04317-C | | Whole | 1.3 | 1.3 | 1.3 |

Table B2-44. Tank 241-B-111 Analytical Results: Chloride (IC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 1,000 | 1,000 | 1,000 |
| 93-04313-C | | Whole | 1,100 | 1,000 | 1,050 |
| 93-04316-C | Core 30 composite | Whole | 1,000 | 1,000 | 1,000[QC:c] |
| 93-04317-C | | Whole | 1,000 | 1,100 | 1,050 |

Table B2-45. Tank 241-B-111 Analytical Results: Fluoride (IC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 1,500 | 1,500 | 1,500 |
| 93-04313-C | | Whole | 1,600 | 1,500 | 1,550 |
| 93-04316-C | Core 30 composite | Whole | 1,600 | 1,600 | 1,600[QC:d] |
| 93-04317-C | | Whole | 1,600 | 1,600 | 1,600 |

Table B2-46. Tank 241-B-111 Analytical Results: Nitrate (IC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 75,000 | 75,000 | 75,000 |
| 93-04313-C | | Whole | 75,000 | 77,000 | 76,000 |
| 93-04316-C | Core 30 composite | Whole | 88,000 | 87,000 | 87,500 |
| 93-04317-C | | Whole | 89,000 | 90,000 | 89,500 |

Table B2-47. Tank 241-B-111 Analytical Results: Nitrite (IC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 49,000 | 49,000 | 49,000 |
| 93-04313-C | | Whole | 49,000 | 50,000 | 49,500 |
| 93-04316-C | Core 30 composite | Whole | 40,000 | 41,000 | 40,500 |
| 93-04317-C | | Whole | 41,000 | 41,000 | 41,000 |

Table B2-48. Tank 241-B-111 Analytical Results: Phosphate (IC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 23,100 | 23,300 | 23,200 |
| 93-04313-C | | Whole | 23,800 | 22,400 | 23,100 |
| 93-04316-C | Core 30 composite | Whole | 24,900 | 23,300 | 24,100 |
| 93-04317-C | | Whole | 25,400 | 25,200 | 25,300 |

Table B2-49. Tank 241-B-111 Analytical Results: Sulfate (IC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 11,800 | 11,800 | 11,800 |
| 93-04313-C | | Whole | 11,800 | 12,100 | 11,950 |
| 93-04316-C | Core 30 composite | Whole | 11,300 | 11,300 | 11,300 |
| 93-04317-C | | Whole | 11,300 | 11,300 | 11,300 |

Table B2-50. Tank 241-B-111 Analytical Results: Ammonium (ISE).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 16 | 28 | 22 |
| 93-04313-C | | Whole | 31 | 38 | 34.5 |
| 93-04316-C | Core 30 composite | Whole | 72 | 59 | 65.5 |
| 93-04317-C | | Whole | 60 | 62 | 61 |

Table B2-51. Tank 241-B-111 Analytical Results: ETOX (Extractable Organic Halides).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-F1 | Core 29 composite | Whole | < 10 | < 10 | < 10 |
| 93-04313-F1 | | Whole | < 10 | < 10 | < 10 |
| 93-04316-F1 | Core 30 composite | Whole | < 10 | < 10 | < 10 |
| 93-04317-F1 | | Whole | < 10 | < 10 | < 10 |

Table B2-52. Tank 241-B-111 Analytical Results: Bis(2-ethylhexyl) phthalate (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-E1 | Core 29 composite | Whole | 2.9 | 3.1 | 3 |
| 93-04313-E1 | | Whole | 3 | 2.8 | 2.9 |
| 93-04316-E1 | Core 30 composite | Whole | 1.7 | 2.9 | 2.3 |
| 93-04317-E1 | | Whole | 2.8 | 2.6 | 2.7 |

Table B2-53. Tank 241-B-111 Analytical Results: Decane (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04316-E1 | Core 30 composite | Whole | 10 | 18 | 14 |
| 93-04317-E1 | | Whole | 20 | 19 | 20 |

Table B2-54. Tank 241-B-111 Analytical Results: Dioctyl adipate (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-E1 | Core 29 composite | Whole | 8.9 | 11 | 9.95 |
| 93-04313-E1 | | Whole | 10 | 10 | 10 |
| 93-04316-E1 | Core 30 composite | Whole | 9.3 | 16 | 12.65 |
| 93-04317-E1 | | Whole | 16 | 15 | 15.5 |

Table B2-55. Tank 241-B-111 Analytical Results: Dodecane (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-E1 | Core 29 composite | Whole | 210 | 250 | 230 |
| 93-04313-E1 | | Whole | 290 | 270 | 280 |
| 93-04316-E1 | Core 30 composite | Whole | 950 | 1,400 | 1,175 |
| 93-04317-E1 | | Whole | 1,500 | 1,500 | 1,500 |

Table B2-56. Tank 241-B-111 Analytical Results: Dodecane,4,6-dimethyl (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04316-E1 | Core 30 composite | Whole | n/d | 11 | 11 |
| 93-04317-E1 | | Whole | 11 | 11 | 11 |

Table B2-57. Tank 241-B-111 Analytical Results: Pentadecane (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-E1 | Core 29 composite | Whole | 19 | 23 | 21 |
| 93-04313-E1 | | Whole | 24 | 22 | 23 |
| 93-04316-E1 | Core 30 composite | Whole | 62 | 93 | 77.5 |
| 93-04317-E1 | | Whole | 97 | 100 | 98.5 |

Table B2-58. Tank 241-B-111 Analytical Results: TBP (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04316-E1 | Core 30 composite | Whole | 14 | 24 | 19 |
| 93-04317-E1 | | Whole | 25 | 25 | 25 |

Table B2-59. Tank 241-B-111 Analytical Results: Tetradecane (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-E1 | Core 29 composite | Whole | 520 | 600 | 560 |
| 93-04313-E1 | | Whole | 620 | 590 | 605 |
| 93-04316-E1 | Core 30 composite | Whole | 1,400 | 1,800 | 1,600 |
| 93-04317-E1 | | Whole | 1,800 | 1,800 | 1,800 |

Table B2-60. Tank 241-B-111 Analytical Results: Tridecane (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-E1 | Core 29 composite | Whole | 680 | 800 | 740 |
| 93-04313-E1 | | Whole | 860 | 820 | 840 |
| 93-04316-E1 | Core 30 composite | Whole | 2,200 | 2,400 | 2,300 |
| 93-04317-E1 | | Whole | 3,100 | 3,000 | 3,050 |

Table B2-61. Tank 241-B-111 Analytical Results: Undecane (SVOA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04316-E1 | Core 30 composite | Whole | 22 | 38 | 30 |
| 93-04317-E1 | | Whole | 42 | 40 | 41 |

Table B2-62. Tank 241-B-111 Analytical Results: Total Carbon (Persulfate Oxidation [TC]).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-J | Core 29 composite | Whole | 4,650 | 5,030 | 4,840 |
| 93-04313-J | | Whole | 4,900 | 4,690 | 4,795 |
| 93-04316-J | Core 30 composite | Whole | 4,960 | 4,980 | 4,970 |
| 93-04317-J | | Whole | 4,680 | 4,550 | 4,615 |

Table B2-63. Tank 241-B-111 Analytical Results: Total Carbon (TC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 5,770 | 5,760 | 5,765 |
| 93-04313-C | | Whole | 5,770 | 5,590 | 5,680 |
| 93-04316-C | Core 30 composite | Whole | 5,250 | 4,770 | 5,010 |
| 93-04317-C | | Whole | 4,900 | 4,900 | 4,900 |

Table B2-64. Tank 241-B-111 Analytical Results: Total Organic Carbon (Persulfate Oxidation [TOC]).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-J | Core 29 composite | Whole | 680 | 820 | 750 |
| 93-04313-J | | Whole | 670 | 560 | 615 |
| 93-04316-J | Core 30 composite | Whole | 1,620 | 1,590 | 1,605 |
| 93-04317-J | | Whole | 1,320 | 1,340 | 1,330 |

Table B2-65. Tank 241-B-111 Analytical Results: Total Organic Carbon (TOC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 780 | 530 | 655 |
| 93-04313-C | | Whole | 1,090 | 750 | 920 |
| 93-04316-C | Core 30 composite | Whole | 720 | 1,250 | 985 |
| 93-04317-C | | Whole | 550 | 1,330 | 940 |

Table B2-66. Tank 241-B-111 Analytical Results: Total Inorganic Carbon (Persulfate Oxidation [TIC]).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µg/g | µg/g | µg/g |
| 93-04312-J | Core 29 composite | Whole | 3,970 | 4,210 | 4,090 |
| 93-04313-J | | Whole | 4,240 | 4,130 | 4,185 |
| 93-04316-J | Core 30 composite | Whole | 3,340 | 3,390 | 3,365 |
| 93-04317-J | | Whole | 3,360 | 3,210 | 3,285 |

Table B2-67. Tank 241-B-111 Analytical Results: Total Inorganic Carbon (TIC).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 93-04312-C | Core 29 composite | Whole | 4,990 | 5,230 | 5,110 |
| 93-04313-C | | Whole | 4,680 | 4,840 | 4,760 |
| 93-04316-C | Core 30 composite | Whole | 4,530 | 3,520 | 4,025 |
| 93-04317-C | | Whole | 4,350 | 3,570 | 3,960 |

Table B2-68. Tank 241-B-111 Analytical Results: Americium-241 (GEA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 91-10553-H1B | 29: 4 | Lower half | < 0.049 | < 0.05 | < 0.0495 |
| 91-10553-H1T | | Upper half | < 0.047 | < 0.05 | < 0.0485 |
| 92-04054-H1B | 30: 3 | Lower half | < 0.055 | 0.0677 | < 0.06135 |
| 92-04054-H1T | | Upper half | < 0.053 | < 0.054 | < 0.0535 |
| 92-04062-H1B | 30: 5 | Lower half | 0.134 | 0.111 | 0.1225 |
| 92-04062-H1T | | Upper half | 0.124 | 0.118 | 0.121 |
| 93-04312-H-1 | Core 29 composite | Whole | 0.064 | 0.088 | 0.076 |
| 93-04313-H-1 | | Whole | 0.14 | 0.13 | 0.135 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.084 | 0.069 | 0.0765 |
| 93-04317-H-1 | | Whole | 0.034 | 0.068 | 0.051 |

Table B2-69. Tank 241-B-111 Analytical Results: Cesium-137 (GEA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 91-10553-H1B | 29: 4 | Lower half | 162 | 163 | 162.5 |
| 91-10553-H1T | | Upper half | 160 | 161 | 160.5 |
| 92-04054-H1B | 30: 3 | Lower half | 145 | 142 | 143.5 |
| 92-04054-H1T | | Upper half | 138 | 139 | 138.5 |
| 92-04062-H1B | 30: 5 | Lower half | 126 | 125 | 125.5 |
| 92-04062-H1T | | Upper half | 125 | 127 | 126 |
| 93-04312-H-1 | Core 29 composite | Whole | 173 | 162 | 167.5 |
| 93-04313-H-1 | | Whole | 190 | 164 | 177 |
| 93-04316-H-1 | Core 30 composite | Whole | 143 | 144 | 143.5 |
| 93-04317-H-1 | | Whole | 142 | 148 | 145 |

Table B2-70. Tank 241-B-111 Analytical Results: Cobalt-60 (GEA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | < 0.005 | < 0.005 | < 0.005 |
| 93-04313-H-1 | | Whole | < 0.005 | < 0.005 | < 0.005 |
| 93-04316-H-1 | Core 30 composite | Whole | < 0.003 | < 0.002 | < 0.0025 |
| 93-04317-H-1 | | Whole | < 0.003 | < 0.003 | < 0.003 |

Table B2-71. Tank 241-B-111 Analytical Results: Europium-154 (GEA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 91-10553-H1B | 29: 4 | Lower half | < 0.014 | < 0.011 | < 0.0125 |
| 91-10553-H1T | | Upper half | < 0.014 | < 0.015 | < 0.0145 |
| 92-04054-H1B | 30: 3 | Lower half | 0.104 | 0.109 | 0.1065 |
| 92-04054-H1T | | Upper half | 0.0887 | 0.108 | 0.09835 |
| 92-04062-H1B | 30: 5 | Lower half | 0.179 | 0.167 | 0.173 |
| 92-04062-H1T | | Upper half | 0.172 | 0.183 | 0.1775 |
| 93-04312-H-1 | Core 29 composite | Whole | 0.22 | 0.177 | 0.1985 |
| 93-04313-H-1 | | Whole | 0.234 | 0.227 | 0.2305 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.12 | 0.133 | 0.1265 |
| 93-04317-H-1 | | Whole | 0.124 | 0.127 | 0.1255 |

Table B2-72. Tank 241-B-111 Analytical Results: Europium-155 (GEA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion | | | µCi/g | µCi/g | µCi/g |
| 91-10553-H1B | 29: 4 | Lower half | < 0.091 | < 0.093 | < 0.092 |
| 91-10553-H1T | | Upper half | < 0.087 | < 0.092 | < 0.0895 |
| 92-04054-H1B | 30: 3 | Lower half | 0.141 | 0.152 | 0.1465 |
| 92-04054-H1T | | Upper half | 0.1 | 0.11 | 0.105 |
| 92-04062-H1B | 30: 5 | Lower half | 0.203 | 0.206 | 0.2045 |
| 92-04062-H1T | | Upper half | 0.18 | 0.201 | 0.1905 |
| 93-04312-H-1 | Core 29 composite | Whole | 0.259 | 0.223 | 0.241 |
| 93-04313-H-1 | | Whole | 0.292 | 0.265 | 0.2785 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.126 | 0.141 | 0.1335 |
| 93-04317-H-1 | | Whole | 0.168 | 0.126 | 0.147 |

Table B2-73. Tank 241-B-111 Analytical Results: U234 to U ratio (Mass Spec.).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | % | % | % |
| 93-04312-H-1 | Core 29 composite | Whole | 0.0057 | 0.003 | 0.00435 |
| 93-04313-H-1 | | Whole | 0.0055 | 0.0054 | 0.00545 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.0056 | 0.0057 | 0.00565 |
| 93-04317-H-1 | | Whole | 0.0057 | 0.0056 | 0.00565 |

Table B2-74. Tank 241-B-111 Analytical Results: U235 to U ratio (Mass Spec.).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | % | % | % |
| 93-04312-H-1 | Core 29 composite | Whole | 0.6582 | 0.6595 | 0.65885 |
| 93-04313-H-1 | | Whole | 0.6661 | 0.6611 | 0.6636 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.6637 | 0.6613 | 0.6625 |
| 93-04317-H-1 | | Whole | 0.6589 | 0.6645 | 0.6617 |

Table B2-75. Tank 241-B-111 Analytical Results: U236 to U ratio (Mass Spec.).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | % | % | % |
| 93-04312-H-1 | Core 29 composite | Whole | 0.0099 | 0.0061 | 0.008 |
| 93-04313-H-1 | | Whole | 0.0104 | 0.0099 | 0.01015 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.0097 | 0.0097 | 0.0097 |
| 93-04317-H-1 | | Whole | 0.0097 | 0.0094 | 0.00955 |

Table B2-76. Tank 241-B-111 Analytical Results: U238 to U ratio (Mass Spec.).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | % | % | % |
| 93-04312-H-1 | Core 29 composite | Whole | 99.3261 | 99.3313 | 99.3287 |
| 93-04313-H-1 | | Whole | 99.3179 | 99.3235 | 99.3207 |
| 93-04316-H-1 | Core 30 composite | Whole | 99.321 | 99.3233 | 99.3221 |
| 93-04317-H-1 | | Whole | 99.3257 | 99.3205 | 99.3231 |

Table B2-77. Tank 241-B-111 Analytical Results: Americium-241 (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 0.0931 | 0.0843 | 0.0887 |
| 93-04313-H-1 | | Whole | 0.0767 | 0.078 | 0.07735 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.0558 | 0.0554 | 0.0556 |
| 93-04317-H-1 | | Whole | 0.0536 | 0.0585 | 0.05605 |

Table B2-78. Tank 241-B-111 Analytical Results: Cm-243/244 (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 3.800E-04 | 2.500E-04 | 3.150E-04 |
| 93-04313-H-1 | | Whole | 1.700E-04 | 1.600E-04 | 1.650E-04 |
| 93-04316-H-1 | Core 30 composite | Whole | 5.300E-04 | 0.002 | 0.001265 |
| 93-04317-H-1 | | Whole | 1.300E-04 | 1.400E-04 | 1.350E-04 |

Table B2-79. Tank 241-B-111 Analytical Results: Curium-242 (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 1.300E-04 | 1.100E-04 | 1.200E-04 |
| 93-04313-H-1 | | Whole | 1.200E-04 | 1.100E-04 | 1.150E-04 |
| 93-04317-H-1 | Core 30 composite | Whole | 5.400E-05 | 7.600E-05 | 6.500E-05 |

Table B2-80. Tank 241-B-111 Analytical Results: Neptunium-237 (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 1.100E-04 | 1.100E-04 | 1.100E-04 |
| 93-04313-H-1 | | Whole | 8.200E-05 | 4.700E-05 | 6.450E-05 |
| 93-04316-H-1 | Core 30 composite | Whole | 6.600E-05 | 5.200E-05 | 5.900E-05 |
| 93-04317-H-1 | | Whole | 5.300E-05 | 5.100E-05 | 5.200E-05 |

Table B2-81. Tank 241-B-111 Analytical Results: Plutonium-238 (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 0.00308 | 0.00377 | 0.003425 |
| 93-04313-H-1 | | Whole | 0.00327 | 0.00336 | 0.003315 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.00298 | 0.00366 | 0.00332 |
| 93-04317-H-1 | | Whole | 0.00236 | 0.00194 | 0.00215 |

Table B2-82. Tank 241-B-111 Analytical Results: Plutonium-239/40 (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 0.0733 | 0.0902 | 0.08175 |
| 93-04313-H-1 | | Whole | 0.104 | 0.107 | 0.1055 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.0951 | 0.105 | 0.10005 |
| 93-04317-H-1 | | Whole | 0.109 | 0.0944 | 0.1017 |

Table B2-83. Tank 241-B-111 Analytical Results: Total alpha Pu (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 0.0764 | 0.0939 | 0.08515 |
| 93-04313-H-1 | | Whole | 0.108 | 0.111 | 0.1095 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.0981 | 0.109 | 0.10355 |
| 93-04317-H-1 | | Whole | 0.111 | 0.0964 | 0.1037 |

Table B2-84. Tank 241-B-111 Analytical Results: Total Alpha (Alpha).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 91-10553-H1B | 29: 4 | Lower half | 0.0757 | 0.089 | 0.08235 |
| 91-10553-H1T | | Upper half | 0.078 | 0.0713 | 0.07465 |
| 92-04054-H1B | 30: 3 | Lower half | 0.125 | 0.103 | 0.114 |
| 92-04054-H1T | | Upper half | 0.127 | 0.149 | 0.138 |
| 92-04062-H1B | 30: 5 | Lower half | 0.122 | 0.141 | 0.1315 |
| 92-04062-H1T | | Upper half | 0.133 | 0.147 | 0.14 |
| 93-04312-H-1 | Core 29 composite | Whole | 0.177 | 0.178 | 0.1775 |
| 93-04313-H-1 | | Whole | 0.186 | 0.204 | 0.195 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.177 | 0.165 | 0.171 |
| 93-04317-H-1 | | Whole | 0.15 | 0.172 | 0.161 |

Table B2-85. Tank 241-B-111 Analytical Results: Strontium-90 (Beta Rad).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 337 | 279 | 308 |
| 93-04313-H-1 | | Whole | 294 | 304 | 299 |
| 93-04316-H-1 | Core 30 composite | Whole | 169 | 175 | 172 |
| 93-04317-H-1 | | Whole | 207 | 219 | 213 |

Table B2-86. Tank 241-B-111 Analytical Results: Technetium-99 (Beta Rad).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 0.13 | 0.124 | 0.127 |
| 93-04313-H-1 | | Whole | 0.12 | 0.127 | 0.1235 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.104 | 0.107 | 0.1055 |
| 93-04317-H-1 | | Whole | 0.0985 | 0.1 | 0.09925 |

Table B2-87. Tank 241-B-111 Analytical Results: Total Beta (Beta Rad).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 736 | 731 | 733.5 |
| 93-04313-H-1 | | Whole | 708 | 724 | 716 |
| 93-04316-H-1 | Core 30 composite | Whole | 520 | 527 | 523.5 |
| 93-04317-H-1 | | Whole | 523 | 552 | 537.5 |

Table B2-88. Tank 241-B-111 Analytical Results: Carbon-14 (Liquid Scintillation).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | µCi/g | µCi/g | µCi/g |
| 93-04312-J-1 | Core 29 composite | Whole | 0.002 | 0.0014 | 0.0017 |
| 93-04313-J-1 | | Whole | 8.100E-04 | 5.200E-04 | 6.650E-04 |
| 93-04316-J-1 | Core 30 composite | Whole | 0.0053 | 0.0011 | 0.0032 |
| 93-04317-J-1 | | Whole | 8.600E-04 | 8.300E-04 | 8.450E-04 |

Table B2-89. Tank 241-B-111 Analytical Results: Carbon-14 (Liquid Scintillation).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-C-1 | Core 29 composite | Whole | < 0.0037 | < 0.0038 | < 0.00375 |
| 93-04313-C-1 | | Whole | 0.0181 | < 0.0031 | < 0.0106 |
| 93-04316-C-1 | Core 30 composite | Whole | < 0.0036 | < 0.003 | < 0.0033 |
| 93-04317-C-1 | | Whole | 0.028 | < 0.0029 | < 0.01545 |

Table B2-90. Tank 241-B-111 Analytical Results: Selenium-79 (Liquid Scintillation).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-H-1 | Core 29 composite | Whole | 9.800E-05 | 8.600E-05 | 9.200E-05 |
| 93-04313-H-1 | | Whole | 1.100E-04 | 9.300E-05 | 1.015E-04 |
| 93-04316-H-1 | Core 30 composite | Whole | 5.900E-05 | 5.500E-05 | 5.700E-05 |
| 93-04317-H-1 | | Whole | 4.100E-05 | 4.600E-05 | 4.350E-05 |

Table B2-91. Tank 241-B-111 Analytical Results: Tritium (Liquid Scintillation).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | µCi/g | µCi/g | µCi/g |
| 93-04312-C-1 | Core 29 composite | Whole | 0.00254 | 0.00192 | 0.00223 |
| 93-04313-C-1 | | Whole | 0.00224 | 0.00267 | 0.002455 |
| 93-04316-C-1 | Core 30 composite | Whole | 0.00332 | 0.00337 | 0.003345 |
| 93-04317-C-1 | | Whole | 0.00354 | 0.00238 | 0.00296 |

Table B2-92. Tank 241-B-111 Analytical Results: Weight Percent Solids (Percent Solids).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | % | % | % |
| 93-04312-K1 | 29: 2 | Whole | 31.5 | 32.3 | 31.9 |
| 93-04312-K2 | 29: 3 | Whole | 31.8 | 31.9 | 31.85 |
| 93-04313-K1 | 29: 4 | Whole | 35.5 | 34.9 | 35.2 |
| 93-04313-K2 | 29: 5 | Whole | 36.1 | 36.4 | 36.25 |
| 93-04316-K1 | 30: 3 | Whole | 33 | 32.9 | 32.95 |
| 93-04316-K2 | 30: 4 | Whole | 35.6 | 34.5 | 35.05 |
| 93-04319-K1 | 30: 5 | Whole | 31.5 | n/d | 31.5 |
| 93-04313-K1 | Core 29 composite II | Whole | 36.2 | 36.3 | 36.25 |
| 93-04312-K1 | Core 29 composite I | Whole | 36.3 | 36.2 | 36.3 |
| 93-04317-K1 | Core 30 composite II | Whole | 37.3 | 37.8 | 37.9 |
| 93-04316-K1 | Core 30 composite I | Whole | 37.6 | 37.3 | 37.5 |

Table B2-93. Tank 241-B-111 Analytical Results: Bulk Density (Physical Properties).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | g/mL | g/mL | g/mL |
| 91-081 | 29: 2 | Whole | 1.2 | n/d | 1.2 |
| 91-082 | 29: 3 | Whole | 1.2 | n/d | 1.2 |
| 91-083 | 29: 4 | Whole | 1.3 | n/d | 1.3 |
| 91-084 | 29: 5 | Whole | 1.3 | n/d | 1.3 |
| 91-086 | 30: 2 | Whole | 0.9 | n/d | 0.9 |
| 91-087 | 30: 3 | Whole | 1.3 | n/d | 1.3 |
| 91-088 | 30: 4 | Whole | 1.3 | n/d | 1.3 |
| 91-089 | 30: 5 | Whole | 1 | n/d | 1 |

Table B2-94. Tank 241-B-111 Analytical Results: Centrifuged Solids Density (Physical Properties).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | g/mL | g/mL | g/mL |
| 91-082 | 29: 3 | Whole | 1.38 | n/d | 1.38 |
| 91-084 | 29: 5 | Whole | 1.45 | n/d | 1.45 |

Table B2-95. Tank 241-B-111 Analytical Results: Centrifuged Supernate Density (Physical Properties).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Liquids | | | g/mL | g/mL | g/mL |
| 91-082 | 29: 3 | Whole | 1.15 | n/d | 1.15 |
| 91-084 | 29: 5 | Whole | 1.17 | n/d | 1.17 |

Table B2-96. Tank 241-B-111 Analytical Results: Shear Strength (Physical Properties).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | dynes/cm2 | dynes/cm2 | dynes/cm2 |
| 91-082 | 29: 3 | Whole | < 300 | n/d | < 300 |
| 91-084 | 29: 5 | Whole | 900 | n/d | 900 |

Table B2-97. Particle Size Distribution for Cores 29 and 30.

| | Particle Size, Microns (by number) | | | Particle Size, Microns (by volume) | | |
|---|---|---|---|---|---|---|
| Segment | Mean | Standard deviation | Median | Mean | Standard deviation | Median |
| Core 29 | | | | | | |
| 2 | 1.23 | 1.46 | 8.96 | 28.74 | 16.49 | 30.91 |
| 3 | 1.46 | 1.55 | 8.96 | 13.61 | 16.88 | 9.89 |
| 4 | 1.31 | 1.39 | 8.91 | 21.18 | 28.58 | 11.58 |
| 5 | 1.53 | 1.51 | 1.16 | 11.12 | 6.11 | 10.62 |
| Core 30 | | | | | | |
| 2 | 21.58 | 23.37 | 9.62 | 21.58 | 23.37 | 9.62 |
| 3 | 1.23 | 1.16 | 8.89 | 11.89 | 9.66 | 7.67 |
| 4 | 8.94 | 8.43 | 8.85 | 6.62 | 7.46 | 2.57 |
| 5 | 1.15 | 8.95 | 8.92 | 22.78 | 19.36 | 16.40 |

Table B2-98. Tank 241-B-111 Analytical Results: pH Measurement (pH).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids: water digest | | | unitless | unitless | unitless |
| 93-04312 | Core 29 composite I | Whole | 8.97 | n/d | 8.97 |
| 93-04313 | Core 29 composite II | Whole | 8.98 | n/d | 8.98 |
| 93-04316 | Core 30 composite I | Whole | 8.74 | n/d | 8.74 |
| 93-04317 | Core 30 composite II | Whole | 8.79 | n/d | 8.79 |

Table B2-99. Tank 241-B-111 Analytical Results: Mass Loss - Transition 1 (TGA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | % | % | % |
| 91-10545 | 29: 2 | Whole | 60 | 59 | 59.5 |
| 91-10549 | 29: 3 | Whole | 60.7 | 61 | 60.85 |
| 91-10553 | 29: 4 | Whole | 54.2 | 53.4 | 53.8 |
| 91-10557 | 29: 5 | Whole | 53.1 | 48.6 | 50.85 |
| 92-04050 | 30: 2 | Whole | 63.4 | 63.3 | 63.35 |
| 92-04054 | 30: 3 | Whole | 61.3 | 62.2 | 61.75 |
| 92-04058 | 30: 4 | Whole | 55.3 | 54 | 54.65 |
| 92-04062 | 30: 5 | Whole | 59.9 | 60.2 | 60.05 |

Table B2-100. Tank 241-B-111 Analytical Results: Mass Loss - Transition 2 (TGA).

| Sample Number | Sample Location | Sample Portion | Result | Duplicate | Mean |
|---|---|---|---|---|---|
| Solids | | | % | % | % |
| 91-10545 | 29: 2 | Whole | 2.2 | 2.4 | 2.3 |
| 91-10549 | 29: 3 | Whole | 3.1 | 3.2 | 3.15 |
| 91-10553 | 29: 4 | Whole | 4.8 | 4.4 | 4.6 |
| 91-10557 | 29: 5 | Whole | 5.2 | 5.8 | 5.5 |
| 92-04050 | 30: 2 | Whole | 3.8 | 3.8 | 3.8 |
| 92-04054 | 30: 3 | Whole | 3.9 | 3.7 | 3.8 |
| 92-04058 | 30: 4 | Whole | 5.1 | 5 | 5.05 |
| 92-04062 | 30: 5 | Whole | 5.2 | 4.8 | 5 |

Table B2-101. Tank 241-B-111 Headspace Flammability Results.

| Measurement | Result |
|---|---|
| TOC | 0 ppm |
| LFL | 0 % |
| Oxygen | n/a |
| Ammonia | 25 ppm |

## B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

The section discusses the overall quality and consistency of the current sampling results for tank 241-B-111 and provides the results the analytical-based inventory calculation.

This section evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess overall data quality and consistency and to identify any limitations in data use.

## B3.1 FIELD OBSERVATIONS

Two issues that may impact the representativeness of samples were noted during extrusion at the 325 Laboratory. The first issue is the lack of recovered waste material from segment 1 for both cores. Hill et al. (1991) expected the first segment of both cores to consist of about 25 cm (9.5 in.) of waste. Almost all segments were completely recovered except for segments 2 and 5 of core 30.

The second issue is HHF contamination of segments 2 and 5 of core 30. Both segments contained a large amount of drainable liquid that made the sample material flow upon extrusion. The liquid was determined to be NPH, which was used as HHF during this sampling event (Giamberardini 1993).

## B3.2 HOMOGENIZATION TESTS

Homogenization is an important step in making representative core composite samples. There were three homogenization steps for core samples from tank 241-B-111. First, the segments from each core were homogenized. Then, aliquotes were taken from the top and bottom portions of the homogenized core 29, segment 4, and core 30, segments 3 and 5. Finally, homogenized waste from each segment was homogenized into composite samples of each core. The samples were prepared by KOH fusion and chemically analyzed using ICP and GEA to determine whether the sample homogenization was adequate.

The following nested random effects model was fit to the analytical results of the aliquotes taken from the top and bottom portions of the homogenized segment samples:

$$Y_{ijk} = \mu + C_i + S_{ij} + H_{ijk} + E_{ijkm}$$

where:

| | | |
|---|---|---|
| $Y_{ijk}$ | = | the measured value of concentration of a constituent in segment *j* of core *i* |
| $\mu$ | = | the mean concentration of the constituent |
| $C_i$ | = | the core sampled |
| $S_{ij}$ | = | the segment from the core |
| $H_{ijk}$ | = | the location of the aliquot (homogenization effect) |
| $E_{ijkm}$ | = | the analytical error. |

The objective of the homogenization test is to determine whether the variability in results between sampling locations is significantly greater than zero. This objective can be met by using the results from an analysis of variance (ANOVA).

Table B3-1 shows the results from the ANOVA. The homogenization relative standard deviation (RSD) (estimated variability between locations relative to the mean) is given, together with the p-value. Each p-value in the table is the probability of obtaining the tabulated RSD value, given that the homogenization variability ($\sigma_H^2$) is equal to zero. If the p-value is less than 0.01, it is concluded that $\sigma_H^2$ is greater than 0 (at the 0.01 level of significance). Analytes with more than 75 percent of the analytical results below the detection limits were excluded from this analysis.

Table B3-1. Homogenization Test Results.

| Segment Level Homogenization Tests (Acid Digestion ICP and GEA) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Homogenization | | | | | Homogenization | | | |
| Analyte | RSD (%) | p-value | <DL | Obs. | Analyte | RSD (%) | p-value | <DL | Obs. |
| Aluminum | 9 | 0.141 | 0 | 12 | Barium | 0 | 0.487 | 4 | 12 |
| Bismuth | 4 | 0.334 | 0 | 12 | Boron | 0 | 0.531 | 1 | 12 |
| Cadmium | 4 | 0.354 | 0 | 12 | Calcium | 13 | 0.019 | 0 | 12 |
| Chromium | 8 | 0.097 | 0 | 12 | Copper | 29 | 0.004 | 3 | 12 |
| Iron | 7 | 0.138 | 0 | 12 | Lead | 15 | 0.021 | 0 | 12 |
| Magnesium | 9 | 0.157 | 4 | 12 | Manganese | 9 | 0.017 | 0 | 12 |
| Phosphorus | 8 | 0.085 | 0 | 12 | Silicon | 13 | 0.016 | 0 | 12 |
| Silver | 0 | 0.539 | 5 | 12 | Sodium | 10 | 0.055 | 0 | 12 |
| Strontium | 7 | 0.110 | 0 | 12 | Titanium | 4 | 0.353 | 4 | 12 |
| Zinc | 15 | 0.002 | 4 | 12 | $^{241}Am$ | 0 | 0.790 | 7 | 12 |
| $^{137}Cs$ | 1 | 0.023 | 0 | 12 | $^{154}Eu$ | 0 | 0.673 | 4 | 12 |
| $^{155}Eu$ | 13 | 0.007 | 4 | 12 | Gross alpha | 6 | 0.281 | 0 | 12 |

Note:

DL = detection limit

The homogenization tests on the segment data show that for 88 percent of the analytes tested, the variability due to homogenization cannot be distinguished from zero (0.01 significance level). For the other 12 percent of the analytes (zinc, $^{155}Eu$, and copper), the homogenization RSDs are relatively small (that is, 10 percent to 15 percent), except for copper. In general, segment homogenization is considered adequate for tank 241-B-111.

## B3.3 QUALITY CONTROL ASSESSMENT

### B3.3.1 Evaluation of Spikes and Blanks

Spikes and blanks are regularly run in the laboratory to determine whether the analysis procedures are producing unbiased measurements. If the results for blanks are too high, or if spike recoveries deviate substantially from 100 percent, the associated measurements are rerun or flagged in the database. The control thresholds used in this QA evaluation have been borrowed from the ground water standards contained in the *Resource Conservation and Recovery Act of 1976* (RCRA) and are not necessarily the most relevant standards to apply.

Blank and spike measurements indicate laboratory performance, but no attempt was made to apply the RCRA standards rigorously to this data. For the analysis in other parts of this report, all data, including QA flagged data, has been used. No attempt was made to correct any data for high blanks or low spike recovery.

### B3.3.2 Quality Assurance Flags

Hanford Analytical Services (HAS) reviewed all data and assigned QA flags to the results. Of the 4,625 measurements in the data set, HAS classified about 12 percent as unusable or "estimate only" (a QA flag of J or Q). All these measurements were used in the analyses. Approximately 49 percent of the measurements were below the detection limit (that is, the analyte was not found in the samples).

To perform the analysis in this report, all data were used and no HAS-flagged data were deleted. Table B3-2 lists the defined HAS flags, and Table B3-3 summarizes the amount of flagged data in the data set. The tables show that much of the data has been flagged as below detection limit (U and UJ); this is not a QA problem. The "Q" flag in Table B3-3 indicates the result is close to the detection limit (that is, above the detection limit but below the quantification limit) and "NF" indicates no flags.

Table B3-3 shows approximately one-third of all ICP-fusion and ICP-acid measurements above the detection limit have a Q flag. Because ICP is the major measurement method for a substantial number of analytes, a large problem would exist with data interpretation if all Q-flagged measurements were deleted from the ANOVA.

### B3.3.3 Blanks

To evaluate blanks, the ratio between the blank and the average result of the sample and its duplicate was computed. Because this ratio would have little meaning when the result is at or below the detection limit, any results at or below detection limits were eliminated. Also, a substantial number of results were eliminated because they did not have an associated sample identification number. Approximately 25 percent of the blanks in the database had no sample identification numbers.

Table B3-2. Quality Assurance Flag Description.

| Flag | Meaning |
|---|---|
| B | Indicates a compound was found in the blank. |
| C | Does not require data qualification but has a potential impact on data quality. |
| E | Indicates the measurement was outside of the calibration range. |
| J | Indicates an estimated value for target and tentatively identified compounds; spectra meet criteria, but response is below Contract Required Quantitation Limit for target compounds. |
| N | Material was not analyzed, because the sample preparation made the measurement inappropriate (for example, potassium in KOH/Ni: fusion preparation). |
| O | Measurement was beyond the range of the instrument. |
| Q | Associated results are qualitative. |
| R | Data are unusable. |
| S | Minimum detection limit was substituted for the reported value of the analytical result. |
| U | Indicates the compound was not detected. The U-flagged concentration is the Contract Required Quantitation Limit. |
| X | Indicates compound was manually deleted because all requirements were not met. |

Table B3-3. Summary of Quality Assurance Flags on Sample and Duplicate Measurements.

| Analysis Method | NF | J | Q | U | UJ |
|---|---|---|---|---|---|
| AA (As):A | 0 | 0 | 0 | 4 | 4 |
| AA (Sb):A | 0 | 0 | 0 | 4 | 4 |
| AA (Se):A | 0 | 0 | 0 | 4 | 4 |
| CVAA (Hg):A | 0 | 0 | 0 | 0 | 0 |
| ICP:A | 186 | 0 | 96 | 178 | 0 |
| CVAA (Hg):A | 4 | 4 | 0 | 0 | 0 |
| DSC:D | 228 | 0 | 0 | 0 | 0 |
| Extractable Organic Halides | 0 | 0 | 0 | 0 | 8 |
| Extraction Organic (SVOA) | 55 | 9 | 0 | 511 | 0 |
| Alpha Radiochemistry:F | 74 | 0 | 0 | 0 | 0 |
| Beta Radiochemistry:F | 24 | 0 | 0 | 0 | 0 |
| GEA:F | 65 | 0 | 0 | 23 | 0 |
| ICP:F | 246 | 0 | 134 | 500 | 0 |
| Laser Fluorimetry:F | 8 | 0 | 0 | 0 | 0 |
| Liquid Scintillation:F | 8 | 0 | 0 | 0 | 0 |
| Mass Spectroscopy:F | 32 | 0 | 0 | 0 | 0 |
| Liquid Scintillation:W | 10 | 0 | 0 | 6 | 0 |
| Liquid Scintillation:A | 8 | 0 | 0 | 0 | 0 |
| Percent Solids:D | 10 | 11 | 0 | 0 | 0 |
| Persulfate Oxidation (TOC):D | 12 | 12 | 0 | 0 | 0 |
| Physical Properties | 19 | 30 | 0 | 1 | 0 |
| TGA:D | 96 | 0 | 0 | 0 | 0 |
| CN:W | 3 | 4 | 0 | 1 | 0 |
| Calorimetric:W | 4 | 4 | 0 | 0 | 0 |
| ICP:W | 70 | 0 | 43 | 301 | 0 |
| IC:W | 24 | 24 | 0 | 0 | 0 |
| ISE ($NH_3$):W | 4 | 4 | 0 | 0 | 0 |
| TIC, TOC, TC:W | 12 | 12 | 0 | 0 | 0 |
| PH:W | 4 | 0 | 0 | 0 | 0 |
| Total Flags | 1,206 | 114 | 273 | 1,533 | 20 |

Table B3-4 summarizes blank/result rates for each analytical method. The table shows the median and maximum ratios for each analytical method, along with the 75 percent quantile.

Table B3-4. Summary of Blank Analyses for Results Above Detection Limit.

| Method | Below DL | Above DL | Median | 75-quantile | Maximum |
|---|---|---|---|---|---|
| ICP:A | 178 | 282 | 14 | 55 | 200 |
| CVAA (Hg):A | 0 | 8 | 1 | 1 | 1 |
| Extraction Organic (SVOA) | 511 | 64 | 200 | 200 | 200 |
| Alpha Radiochemistry:F | 0 | 74 | 0 | 0 | 51 |
| Beta Radiochemistry:F | 0 | 24 | 0 | 1 | 1 |
| GEA:F | 23 | 65 | 0 | 0 | 1 |
| ICP:F | 500 | 380 | 36 | 67 | 200 |
| Laser Fluorimetry:F | 0 | 8 | 0 | 0 | 0 |
| Liquid Scintillation:F | 0 | 8 | 37 | 45 | 53 |
| Liquid Scintillation:W | 6 | 10 | 15 | 16 | 17 |
| CN- | 1 | 7 | 45 | 50 | 56 |
| Calorimetry:W | 0 | 8 | 62 | 67 | 71 |
| ICP:W | 301 | 113 | 22 | 84 | 115 |
| IC:W | 0 | 48 | 0 | 3 | 4 |
| ISE (NH3):W | 0 | 8 | 15 | 19 | 23 |
| TIC, TOC, TC:W | 0 | 24 | 3 | 9 | 12 |

Some analytical methods show very few blank/result ratios (such as CVAA, radiochemistry, GEA, and laser fluorimetry). The major analytical method, ICP, shows a large number of blanks. These results are not surprising because ICP analytical methods are commonly known to have large blank/result ratios. A common laboratory practice is to use the blanks to correct for background effects, and these measurements show that alterations in laboratory procedure may be appropriate.

### B3.3.4 Spikes

Spike recovery percentages are generally between 75 and 125 percent, except for selenium and cyanide measurements. Only six spikes were outside the range. Although most recoveries are within the desired 75 to 125 percent, a question exists about whether this information should be used to correct for biases. For several important measurement methods (that is, fusion GEA, alpha and beta radiochemistry), the results are consistently above or below 100 percent recovery. This consistency in the recoveries indicates that a bias may exist in analytical methods. The variability in the recovery percents is small for several analytical methods.

### B3.3.5 Relative Percent Differences

Analytical precision is estimated by the RPD, which is defined as the absolute value of the difference between primary and duplicate sample results, divided by their mean, times 100. One composite sample from core 30 exhibited a high RPD value when analyzed for $^{14}C$ liquid scintillation. The results were attributed to a nearly dry sample, which may cause inhomogeneity and difficulty in obtaining reliable analyses (Giamberardini 1993).

## B3.4 DATA CONSISTENCY CHECKS

Comparing different analytical methods can be useful in assessing data consistency and quality. Several correlations were possible with the data set provided by the two core samples. These included a comparison of phosphorus as analyzed by ICP with phosphate as analyzed by IC, and the comparisons of the gross alpha and gross beta results with the sum of the alpha and beta emitters, respectively. In addition, mass and charge balances were calculated to help assess overall data consistency.

### B3.4.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two different analytical methods. A close agreement between the two methods strengthens the credibility of both results, whereas a poor agreement brings the reliability of the data into question. All analytical mean results were taken from Table B3-12.

Table B3-5 compares the ICP phosphorus concentration mean to the phosphate concentration mean as determined by IC analysis. The ICP phosphorus result, which represents total phosphorus, was 15,900 $\mu$g/g. The IC phosphate value of 23,900 $\mu$g/g, which is a measurement of the water-soluble phosphorus in the form of phosphate, converted to 7,800 $\mu$g/g of phosphorus. The ratio between these two phosphate values was 2.04, indicating that approximately half the phosphorus in the tank is water soluble.

Table B3-5. Tank 241-B-111 Comparison of Phosphorus Concentration with the Equivalent Concentration of Phosphate.

| Analyte | Overall Mean ($\mu$g/g) |
|---|---|
| Measured mean phosphorus concentration by ICP | 15,900 |
| Phosphorus concentration from phosphate by IC | 7,800 |
| Ratio | 2.04 |

Table B3-6 compares the total alpha activity mean and the sum of the activity means of the individual alpha emitters. The sum of the activities of the individual alpha emitters was 0.185 $\mu$Ci/g and was determined by adding the $^{241}$Am, $^{238}$Pu, and $^{239/240}$Pu mean activities, the three major alpha emitters. The total alpha activity was 0.176 $\mu$Ci/g, yielding a ratio between the two methods of 1.05. This ratio indicates good agreement between the two methods.

Table B3-6. Tank 241-B-111 Comparison of Total Alpha Activity Mean and the Individual Alpha Emitters.

| Analyte | Overall Mean ($\mu$Ci/g) |
|---|---|
| $^{241}$Am | 0.0846 |
| $^{238}$Pu | 0.00305 |
| $^{239/240}$Pu | 0.09725 |
| Sum of the alpha emitters | 0.185 |
| Total alpha activity | 0.176 |
| Ratio | 1.05 |

Table B3-7 compares the total beta activity mean and the sum of the activity means of the individual beta emitters. The sum of the activities of the individual beta emitters was determined by adding the $^{137}$Cs and $^{89/90}$Sr activities. Because $^{89/90}$Sr is in equilibrium with its daughter product $^{90}$Y, the $^{89/90}$Sr must be multiplied by 2 to account for all beta emitters. The total beta activity result was 628 $\mu$Ci/g, and the sum of the beta emitters was 654 $\mu$Ci/g. The total values agree as evidenced by the ratio of 1.04.

Table B3-7. Tank 241-B-111 Comparison of Total Beta Activity Mean and the Individual Beta Emitters.

| Analyte | Overall Mean (μCi/g) |
|---|---|
| $^{89/90}Sr$ | 248 * 2 = 496 |
| $^{137}Cs$ | 158 |
| Sum of beta emitters | 654 |
| Total beta activity | 628 |
| Ratio | 1.04 |

### B3.4.2 Mass and Charge Balance

The principle objective in performing mass charge balances is to determine whether the measurements are consistent. The best estimates of tank contents for the metals and anions are summed to postulate the amount of water present in the tank. The postulated water content is compared to the measured water content.

It is assumed that all boron, phosphorus, selenium, silicon, and tellurium measured in the core samples are present in their oxygenated anion forms (see Table 3-8). To estimate complexed hydroxide, a charge balance is calculated, and the appropriate amount of hydroxide is added to balance the charges. Table B3-8 lists the anions with postulated oxy-anions used in the mass and charge balances.

Table B3-9 lists the metals (cations). All the concentrations in the tables are the best estimates of tank contents (Benar 1996). The tables also list the RSD associated with each estimate and its postulated charge. The RSDs are used to calculate the uncertainties associated with the mass totals.

Table B3-10 summarizes the mass and charge balances from Tables B3-8 and B3-9 and the uncertainties associated with each total (expressed as RSD). Total charges are listed in column 4. The excess negative charge is determined from these totals. The excess negative charge is hydroxide, and the charge balance determines the mass of hydroxide. The mass concentration, μg/g, or ppm resulting from the cations, anions, and predicted hydroxide is therefore subtracted from 1 million to estimate the water content. The postulated water content in the waste is 63.7 percent, within 1 percent agreement with the measured result. The estimated total mass is 994,000 μg/g which is only -0.6 percent different from the total mass (1,000,000 μg/g) of the waste. The mass balance indicates, the assumptions made concerning the hydroxide and oxygen seem to fit the data well.

Table B3-8. Anion Mass and Charge Balance Contribution with Postulated Oxy-Anions.

| Anion | Mass | | Charge | Postulated Oxygen | | |
|---|---|---|---|---|---|---|
| | μg/g | RSD % | μmol/g | Anion | μg/g | RSD % |
| Boron | 51 | 7 | 2.38 | $B_4O_7^{-2}$ | 133 | 7 |
| Chloride | 1,020 | 2 | 28.77 | --- | --- | --- |
| Cyanide | 2 | 19 | 0.07 | --- | --- | --- |
| Fluoride | 1,560 | 2 | 82.11 | --- | --- | --- |
| Nitrate | 82,000 | 8 | 1322.58 | --- | --- | --- |
| Nitrite | 45,000 | 9 | 987.26 | --- | --- | --- |
| Phosphorus | 15,900 | 8 | 1540.2 | $PO_4^{-3}$ | 32,913 | 8 |
| Selenium | 22 | 15 | 1.12 | $SeO_3^{-2}$ | 13 | 15 |
| Silicon | 10,400 | 8 | 742.86 | $SiO_3^{-2}$ | 17,784 | 8 |
| Sulfate | 11,600 | 1 | 362.5 | --- | --- | --- |
| Tellurium | 21 | 5 | 0.32 | $TeO_3^{-2}$ | 8 | 6 |

Table B3-9. Metals (Cations) Mass and Charge Contribution. (2 sheets)

| Metal | Mass | | Charge | Metal | Mass | | Charge |
|---|---|---|---|---|---|---|---|
| | μg/g | RSD % | μmol/g | | μg/g | RSD % | μmol/g |
| Aluminum | 899 | 7 | 99.96 | Antimony | 11 | 9 | 0.26 |
| Arsenic | 28 | | 1.12 | Barium | 28 | 11 | 0.41 |
| Beryllium | 2 | | 0.39 | Bismuth | 20,200 | 1 | 289.98 |
| Cadmium | 3 | 15 | 0.05 | Calcium | 689 | 23 | 34.38 |
| Cerium | 21 | 9 | 0.44 | Chromium | 1,110 | 5 | 64.04 |
| Cobalt | 4 | 21 | 0.15 | Copper | 201 | 94 | 6.33 |
| Dysprosium | 7 | | 0.13 | Europium | 3 | | 0.07 |
| Gadolinium | 70 | | 1.33 | Iron | 17,700 | 5 | 950.81 |
| Lanthanum | 7 | 6 | 0.15 | Lead | 1,570 | 7 | 15.16 |

Table B3-9. Metals (Cations) Mass and Charge Contribution. (2 sheets)

| Metal | Mass | | Charge | Metal | Mass | | Charge |
|---|---|---|---|---|---|---|---|
| | μg/g | RSD % | μmol/g | | μg/g | RSD % | μmol/g |
| Lithium | 7 | | 1.00 | Magnesium | 195 | 2 | 16.04 |
| Manganese | 79 | 6 | 2.87 | Molybdenum | 42 | 9 | 2.61 |
| Neodymium | 22 | 23 | 0.46 | Nickel | 19 | 3 | 0.63 |
| Palladium | 52 | | 0.99 | Potassium | 674 | 18 | 17.24 |
| Rhodium | 35 | | 1.02 | Ruthenium | 17 | | 0.52 |
| Sodium | 95,700 | 2 | 4162.72 | Strontium | 218 | 2 | 4.98 |
| Thallium | 174 | | 0.85 | Thorium-232 | 279 | | 4.81 |
| Tin | 279 | | 9.40 | Titanium | 8 | 14 | 0.66 |
| Tungsten | 28 | | 0.91 | Uranium | 197 | 4 | 4.97 |
| Vanadium | 2 | 12 | 0.24 | Yttrium | 2 | 21 | 0.08 |
| Zinc | 111 | 50 | 3.40 | Zirconium | 14 | 29 | 0.63 |

Table B3-10. Summary of Mass/Charge Balance.

| Source | Mass | | Charge |
|---|---|---|---|
| | μg/g | RSD | μmol/g |
| Sum of Cations (Metals) | 140,708 | 2 | 5,702 |
| Sum of Anions | 167,576 | 4 | -2,777 |
| Estimated Oxygen | 50,851 | 6 | -2,284 |
| Estimated Hydroxide | 3,990 | 0 | -641 |
| Subtotal | 363,000 | n/a | 0 |
| Postulated $H_2O$ from Mass Balance | 637,000 | 1 | |
| Measured $H_2O$ | 630,000 | 2 | |
| Relative Percent Difference ($H_2O$) | 1 | | |
| Estimated Total (subtotal + $H_2O$) | 994,000 | | |
| Percent Difference from Total | -0.6 | | |

## B3.5 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The core composite data were used to determine mean concentrations and associated uncertainties. These values were used to estimate the waste inventory of tank 241-B-111. The available segment-level data was used to conduct the sample homogenization tests and to determine the physical properties of tank 241-B-111 waste. This section gives a summary of the results from the statistical analysis. The complete results are contained in Benar (1996) and Remund et al. (1994).

### B3.5.1 Mean Concentrations

Table B3-11 gives the estimated mean concentration and its associated RSD for each constituent. These results were obtained by fitting a random effects statistical model to the data. The RSD, defined as the square root of the variance estimate divided by the estimated mean of the constituent multiplied by 100, indicates how large the variance estimate is relative to the mean.

If more than 75 percent of the sample results for a given constituent were below the detection limit, the statistical model was not fit to the data. In that case, a mean (including the detection limits) was calculated, and RSDs were not calculated. Some constituents shown were analyzed by more than one method, but only the results from the preferred analytical method are shown. The complete set of constituent results (for all constituents and analytical methods), including the individual variance component estimates, are in Benar (1996) and Remund et al. (1994).

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.[1] (5 sheets)

| Analyte | Analytical Method: Sample Preparation | Mean Concentration | |
|---|---|---|---|
| | | Composite | RSD (mean) |
| **Anions** | | (µg/g) | % |
| Chloride | IC:W | 1,020 | 2 |
| Cyanide | CN:W | 1.88 | 19 |
| Fluoride | IC:W | 1,560 | 2 |
| Nitrate | IC:W | 8.20E+04 | 8 |
| Nitrite | IC:W | 4.50E+04 | 9 |
| Phosphate | IC:W | 2.39E+04 | 3 |
| Sulfate | IC:W | 1.16E+04 | 1 |

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.[1] (5 sheets)

| Analyte | Analytical Method: Sample Preparation | Mean Concentration | |
|---|---|---|---|
| | | Composite | RSD (mean) |
| Cations | | (µg/g) | % |
| Aluminum | ICP:A | 899 | 7 |
| Ammonia | ISE:W | 45.8 | 38 |
| Antimony | ICP:A | 18.3 | 28 |
| Arsenic | ICP:A | 27.9 | n/a |
| Barium | ICP:A | 28.2 | 11 |
| Bismuth | ICP:F | 2.02E+04 | 1 |
| Boron | ICP:A | 51.4 | 7 |
| Cadmium | ICP:A | 2.77 | 15 |
| Calcium | ICP:A | 689 | 23 |
| Cerium | ICP:A | 32.1 | 24 |
| Chromium | ICP:A | 1,110 | 5 |
| Cobalt | ICP:A | 4.43 | 21 |
| Copper | ICP:A | 201 | 94 |
| Hexavalent chromium | Colorimetric:W | 161 | 6 |
| Iron | ICP:F | 1.77E+04 | 5 |
| Lanthanum | ICP:A | 11.3 | 27 |
| Lead | ICP:A | 1,570 | 7 |
| Magnesium | ICP:A | 195 | 2 |
| Manganese | ICP:A | 78.9 | 6 |
| Mercury | CVAA(Hg):A | 9.32 | 50 |
| Molybdenum | ICP:A | 41.7 | 9 |
| Neodymium | ICP:A | 22.1 | 23 |
| Nickel | ICP:A | 20.7 | 7 |
| Palladium | ICP:A | 52.5 | n/a |
| Phosphorus | ICP:F | 1.59E+04 | 8 |

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.[1] (5 sheets)

| Analyte | Analytical Method: Sample Preparation | Mean Concentration | |
|---|---|---|---|
| | | Composite | RSD (mean) |
| Potassium | ICP:A | 674 | 18 |
| Selenium | ICP:A | 32.3 | 22 |
| Silicon | ICP:F | 1.04E+04 | 8 |
| Silver | ICP:A | 5.95 | 26 |
| Sodium | ICP:F | 9.57E+04 | 2 |
| Strontium | ICP:A | 218 | 2 |
| Tellurium | ICP:A | 36 | 28 |
| Titanium | ICP:A | 7.90 | 14 |
| Uranium | Laser Fluorimetry:F | 197 | 4 |
| Vanadium | ICP:A | 3.93 | 25 |
| Yttrium | ICP:A | 3.93 | 25 |
| Zinc | ICP:A | 111 | 50 |
| Zirconium | ICP:A | 14.4 | 29 |
| **Organics** | | **(μg/g)** | **%** |
| Bis(2-ethylhexyl) phthalate | SVOA | 2.73 | 8 |
| Decane | SVOA | 16.8 | 16 |
| Di-n-butylphthalate | SVOA | 8.44 | n/a |
| Dioctyl adipate | SVOA | 12.0 | 17 |
| Dodecane | SVOA | 796 | 68 |
| Naphthalene | SVOA | 9.61 | n/a |
| Nitrobenzene | SVOA | 9.61 | n/a |
| Pentachlorophenol | SVOA | 48.1 | n/a |
| Pentadecane | SVOA | 55.0 | 60 |
| Phenanthrene | SVOA | 9.61 | n/a |
| Phenol | SVOA | 9.61 | n/a |
| Tetradecane | SVOA | 1,140 | 49 |

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.[1] (5 sheets)

| Analyte | Analytical Method: Sample Preparation | Mean Concentration | |
|---|---|---|---|
| | | Composite | RSD (mean) |
| Total carbon | Persulfate Oxidation:W | 5,340 | 7 |
| Total inorganic carbon | Persulfate Oxidation:W | 4,460 | 11 |
| Total organic carbon | Persulfate Oxidation:W | 875 | 12 |
| Tributyl phosphate | SVOA | 22.0 | 14 |
| Tridecane | SVOA | 1,730 | 54 |
| Undecane | SVOA | 35.5 | 15 |
| **Physical Properties** | | | |
| pH Measurement | pH:W | 8.87 | 1 |
| Weight percent solids | Percent Solid:D | 36.9% | 2 |
| **Radionuclides** | | (µCi/g) | % |
| Americium-241 | GEA:F | 0.0846 | 25 |
| Carbon-14 | Liquid Scintillation:W | 0.0016 | 36 |
| Cesium-137 | GEA:F | 158 | 9 |
| Cobalt-60 | GEA:F | <0.00387 | n/a |
| Curium-242 | Alpha Radchem:F | 9.16E-05 | 29 |
| Curium-243/244 | Alpha Radchem:F | 4.70E-04 | 57 |
| Europium-154 | GEA:F | 0.170 | 26 |
| Europium-155 | GEA:F | 0.20 | 30 |
| Gross alpha[2] | Alpha Radchem:F | 0.176 | 6 |
| Gross beta | Beta Radchem:F | 628 | 15 |
| Neptunium-237 | Alpha Radchem:F | 7.14E-05 | 22 |
| Plutonium-238 | Alpha Radchem:F | 0.00305 | 10 |
| Plutonium-239/240 | Alpha Radchem:F | 0.0973 | 5 |
| Strontium-90 | Beta Radchem:F | 248 | 22 |
| Technetium-99 | Beta Radchem:F | 0.114 | 10 |
| Thorium-232 | ICP:A | <279 | n/a |

Table B3-11. Summary of the Composite Level Results for Anions, Metals, Organics, and Radionuclides.[1] (5 sheets)

| Analyte | Analytical Method: Sample Preparation | Mean Concentration | |
|---|---|---|---|
| | | Composite | RSD (mean) |
| Total alpha Pu[2] | Alpha Radchem:F | 0.10 | 5 |
| Tritium | Liquid Scintillation:W | 0.00275 | 15 |
| Uranium-234[3] | Mass Spectrometry:F | 0.00527% | 7 |
| Uranium-235[3] | Mass Spectrometry:F | 0.662% | 0 |
| Uranium-236[3] | Mass Spectrometry:F | 0.00935% | 5 |
| Uranium-238[3] | Mass Spectrometry:F | 99.3% | 0 |

Notes:

[1]Benar (1996)
[2]Total alpha emitted from $^{238}Pu$, $^{239}Pu$, $^{240}Pu$.
[3]These are mass percents of total uranium.

### B3.5.2 Analysis of Variance Model

As a result of the sampling structure in tank 241-B-111 composite data, the following random effects ANOVA model was fit to the data to estimate the mean concentration and variability of each chemical and radiological constituent:

$$Y_{ijk} = \mu + C_i + S_{ij} + E_{ijk}$$

where:

$Y_{ijk}$ = the measured value of concentration of a constituent in replicate *j* of core *i*

$\mu$ = the mean concentration of the constituent

$C_i$ = the deviation of concentration in core *i* from the mean value

$S_{ij}$ = the deviation of concentration in core replicates from the mean value (two replicates were processed on each composite)

$E_{ijk}$ = the analytical (lab) error in the measurement.

The random variables $C_i$, $S_{ij}$, and $E_{ijk}$, are assumed to be uncorrelated with zero means and variances $\sigma_C^2$, $\sigma_S^2$, and $\sigma_E^2$, respectively. Each term in the model describes the contribution to the variability of a step in the sampling and measurement process. For each constituent, this model can be used to obtain a mean concentration estimate and its associated uncertainty. This model can also be used to obtain estimates of horizontal variability ($\sigma_C^2$), sampling variability ($\sigma_S^2$), and analytical variability ($\sigma_E^2$) for each constituent.

Statistical difference in the mean values between the two cores were determined using ANOVA. Constituents were excluded from this analysis (that is, no ANOVA was run) if 75 percent or more of the sample and duplicate results were below the detection limit.

## B4.0 APPENDIX B REFERENCES

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DeLorenzo, D. S., J. H. Rutherford, D. J. Smith, D. B. Hiller, K. W. Johnson, and B. C. Simpson, 1994, *Tank Characterization Reference Guide*, WHC-SD-WM-TI-648, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Remund, K. M., J. M. Tingey, P. G. Heasler, J. J. Toth, F. M. Ryan, S. A. Hartley, D. B. Simpson, and B. C. Simpson, 1994, *Tank Characterization Report for Single-Shell Tank B-111*, PNL-10099, Pacific Northwest National Laboratory, Richland, Washington.

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# APPENDIX C

# STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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# APPENDIX C

## C1.0 STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

Appendix C discusses the statistical analyses required by the safety screening DQO (Dukelow et al. 1995) for tank 241-B-111. The only statistical analyses required were to calculate upper limits to 95 percent confidence intervals on the mean for total alpha activity (criticality). Confidence intervals were not completed using on the DSC data because there were no exothermic reactions. Because the safety screening DQO was not applicable to the 1991 core sampling event, the results of these confidence intervals are provided for informational purposes only.

The safety screening DQO defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals on the mean for each subsample. All data considered in this section were taken from the final laboratory data package (Giamberardini 1993), and were presented in Table B2-84.

The upper limit to a one-sided 95 percent confidence interval for the mean is:

where $\hat{\mu}$ is the mean of the data, $n$ is the number of observations, $\hat{\sigma}^2$ is the estimate of the variance, and $t_{(n-1,0.05)}$ is a quantile from Student's t distribution with $n$-$1$ degrees of freedom, for a one-sided 95 percent confidence interval. For the tank 241-B-111 data (per sample number), n is two and $t_{(1,0.05)}$ is 6.314.

Table C1-1 lists the upper limit of the 95 percent confidence interval for each sample number based on the total alpha activity data. Each confidence interval can be used to make the following statement. If the upper limit is less than 46.9 $\mu$Ci/g, reject the null hypothesis that the total alpha was greater than or equal to 46.9 $\mu$Ci/g at the 0.05 level of significance. The upper limit of 46.9 $\mu$Ci/g was calculated from the 1 g/L plutonium limit assuming a density of 1.31 g/mL (Benar 1996) and assuming that all the plutonium is $^{239}$Pu. The table shows all total alpha activity 95 percent confidence interval upper limits were well below the 46.9 $\mu$Ci/g threshold.

Table C1-1. 95 Percent Confidence Interval Upper Limits For Total Alpha Activity for Tank 241-B-111.

| Sample Number | Sample Location | Sample Portion | Mean | Upper Limit |
|---|---|---|---|---|
| Solids: fusion digest | | | µCi/g | µCi/g |
| 91-10553-H1B | 29: 4 | Lower half | 0.08235 | 0.124 |
| 91-10553-H1T | | Upper half | 0.07465 | 0.0958 |
| 92-04054-H1B | 30: 3 | Lower half | 0.114 | 0.183 |
| 92-04054-H1T | | Upper half | 0.138 | 0.207 |
| 92-04062-H1B | 30: 5 | Lower half | 0.1315 | 0.191 |
| 92-04062-H1T | | Upper half | 0.14 | 0.184 |
| 93-04312-H-1 | Core 29 composite | Whole | 0.1775 | 0.181 |
| 93-04313-H-1 | | Whole | 0.195 | 0.252 |
| 93-04316-H-1 | Core 30 composite | Whole | 0.171 | 0.209 |
| 93-04317-H-1 | | Whole | 0.161 | 0.23 |

## C2.0 APPENDIX C REFERENCES

Benar, C. J., 1996, *Tank Characterization Report for Single-Shell Tank 241-B-111*, WHC-SD-WM-ER-549, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Characterization Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Giamberardini, K. K., 1993, *PNL 325 Laboratories Single-Shell Tank Waste Characterization, Tank 241-B-111 Cores 29 and 30*, WHC-SD-WM-DP-041, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

# APPENDIX D

## BEST-BASIS FOR SINGLE-SHELL TANK 241-B-111

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# APPENDIX D

# BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-B-111

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for waste management activities (Kupfer 1996). As part of this effort, an evaluation of available chemical information for tank 241-B-111 was performed, and a best-basis inventory was established. This work follows the methodology established by the standard inventory task.

## D1.0 IDENTIFY/COMPILE INVENTORY SOURCES

The TCR for tank 241-B-111 (Giamberardini 1993) provides characterization results from the 1991 sampling event for this tank. Two core samples were obtained and analyzed. A sample-based inventory was prepared based on the core sample analytical results using a waste density of 1.19 g/mL, and a waste volume of 897 kL (237 kgal). This waste volume is the total waste volume which includes 893 kL (236 kgal) of sludge and 4 kL (1kgal) of supernatant. The HDW model (Agnew et al. 1996a) provides tank contents estimates, derived from process flowsheets and waste volume records.

## D2.0 COMPARE COMPONENT INVENTORY VALUES AND NOTE SIGNIFICANT DIFFERENCES

Tables D2-1 and D2-2 show the sample-based inventory estimate from the TCR and the inventory estimate from the HDW model (Agnew et al. 1996a) for tank 241-B-111. The waste solids volume used to generate both inventories is 893 kL (236 kgal). The estimates, however, use different waste densities. The sample-based inventory used a bulk density of 1.19 g/mL, which is the overall tank density calculated from the sample data (Giamberardini 1993). The HDW model uses a lower waste density, 1.16 g/mL, which is an estimate derived from process flowsheets and waste volume records. Several significant differences between the sample-based and HDW model inventories are apparent, for example, Al, Bi, Ca, Cl, Cr, Fe, Hg, K, Mn, Na, $NH_4$, Ni, $NO_2$, $NO_3$, Pb, $PO_4$, Si, S, U, and Zr vary by a factor of two or more.

Table D2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-B-111. (2 sheets)

| Analyte | Sampling Inventory Estimate (kg) | HDW Model Inventory Estimate (kg) | Analyte | Sampling Inventory Estimate (kg) | HDW Model Inventory Estimate (kg) |
|---|---|---|---|---|---|
| Al | 958 | 166 | Ni | 22.1 | 496 |
| Ag | 6.34 | --- | $NO_2$ | 47,900 | 3,110 |
| As | 29.7 | --- | $NO_3$ | 87,400 | 32,700 |
| B | 54.8 | --- | OH | --- | 50,900 |
| Ba | 30 | --- | oxalate | --- | 0.0012 |
| Be | <1.85 | --- | Pb | 1,670 | 1.27 |
| Bi | 21,500 | 6,790 | Pd | 55.9 | --- |
| Ca | 734 | 9,860 | P as $PO_4$ | 51,800 | 10,600 |
| Ce | 34.2 | --- | Pt | --- | --- |
| Cd | 2.95 | --- | Re | --- | --- |
| Cl | 1,090 | 546 | Rh | <37.2 | --- |
| Co | 4.72 | --- | Ru | <18.5 | --- |
| Cr | 1,180 | 408 | Sb | 19.5 | --- |
| $Cr^{+3}$ | --- | 408 | Se | 34.4 | --- |
| $Cr^{+6}$ | --- | --- | Si | 11,100 | 4,620 |
| Cs | --- | --- | S as $SO_4$ | 12,400 | 3,400 |
| Cu | 214 | --- | Sn | <297 | --- |
| F | 1,660 | 1,650 | Sr | 232 | 0.00046 |
| Fe | 18,900 | 51,800 | Te | 38.4 | -- |
| FeCN/CN | 2.0 | 0 | TIC as $CO_3$ | 23,600 | 14,800 |
| Formate | --- | --- | Th | <2.75E+06 | --- |
| Hg | 9.93 | 0.0077 | Ti | 8.42 | -- |
| K | 718 | 133 | TOC | 932 | -- |
| La | 12 | 0.0022 | total U | 210 | 4,120 |
| Li | <7.43 | --- | V | 4.19 | --- |
| Mg | 208 | --- | W | <29.7 | --- |

Table D2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-B-111. (2 sheets)

| Analyte | Sampling Inventory Estimate (kg) | HDW Model Inventory Estimate (kg) | Analyte | Sampling Inventory Estimate (kg) | HDW Model Inventory Estimate (kg) |
|---|---|---|---|---|---|
| Mn | 84.1 | 0.88 | Zn | 118 | --- |
| Mo | 44.4 | --- | Zr | 15.3 | 1.27 |
| Na | 102,000 | 31,800 | $H_2O$(Wt%) | 63.1 | 78.2 |
| Nd | 23.5 | --- | Density (kg/L) | 1.19 | 1.16 |
| $NH_4$ | 48.8 | 430 | | | |

Table D2-2. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Radioactive Components in Tank 241-B-111.

| Analyte | Sampling inventory estimate (Ci) | HDW model inventory estimate (Ci) | Analyte | Sampling inventory estimate (Ci) | HDW model inventory estimate (Ci) |
|---|---|---|---|---|---|
| $^{14}C$ | 17 | n/r | $^{237}Np$ | 0.0761 | n/r |
| $^{90}Sr$ | 264,000 | 1,350,000 | $^{239/240}Pu$ | 104 | 157 |
| $^{99}Tc$ | 121 | n/r | $^{241}Am$ | 90.1 | n/r |
| $^{129}I$ | n/r | n/r | Total $\alpha$ | 188 | n/r |
| $^{137}Cs$ | 168,000 | 56,100 | Total $\beta$ | 669,000 | n/r |
| $^{154}Eu$ | 181 | n/r | | | |

Note:

n/r = not reported

## D3.0 REVIEW AND EVALUATION OF COMPONENT INVENTORIES

The following evaluation of tank contents is performed to identify potential errors and/or missing information that could influence the sample-based and HDW model component inventories.

### D3.1 CONTRIBUTING WASTE TYPES

Tank 241-B-111 was put into service in December 1945 as the second tank in a three-tank cascade that also included tanks 241-B-110 and 241-B-112 cascade. The cascade received 2C waste from B Plant. Waste began overflowing to tank 241-B-112 in April 1946.
Tank 241-B-112 was filled in August 1946, and the 2C waste was diverted to a cascade that included tanks 241-B-104, 241-B-105, and 241-B-106 cascade.

After the 241-B-104, 241-B-105 and 241-B-106 cascade was filled, the supernatant from the 241-B-110 cascade was pumped to cribs. The 241-B-110 cascade again received 2C waste from B Plant in July 1950 and continued to do so until B Plant was shut down in June 1952. Tank 241-B-112 began overflowing to a crib in second quarter of 1951 (Anderson 1990).

After B Plant was shut down in June 1952, the 241-B-110 cascade began receiving a concentrated flush waste from B Plant. This concentrate showed up in tank 241-B-111 in the third quarter of 1952. In 1963, tank 241-B-111 began receiving fission product waste from B Plant via tank 241-B-110.

Table D3-1 shows the current waste volumes for the tanks in the 241-B-110 cascade(Hanlon 1996).

Table D3-1. Waste Inventory of 241-B-110, 241-B-111, and 241-B-112 Cascade.

| Inventory | Tank 241-B-110 (kL) | Tank 241-B-111 (kL) | Tank 241-B-112 (kL) |
|---|---|---|---|
| Sludge | 927 | 893 | 114 |
| Saltcake | 0 | 0 | 0 |
| Supernatant | 4 | 4 | 11 |
| Drainable liquid | 83 | 79 | 0 |

Table D3-2 lists the documented quantities of waste discharged to tank 241-B-111 from the HDW model waste transaction database.

Table D3-2. Waste Transaction Information for Tank 241-B-111.

| | Waste Type | Waste Volume (kL) |
|---|---|---|
| Waste throughput | 2C2 | n/r |
| | DW | 818 |
| | P2 (PUREX high-level waste 1964-1967) | 2,532 |
| | CSR (Waste sent to B Plant for cesium recovery) | 7,093 |
| Total waste throughput | | 10,443 |
| Current inventory | | 893 |

Note:

[1]Agnew et al. (1996)

Table D3-3 shows the types of solids accumulated in tank 241-B-111 that were reported by various authors. All sources indicate that second cycle bismuth phosphate waste should be the principal contribution to the waste solids in the tank.

Table D3-3. Expected Solids for Tank 241-B-111.

| Reference | Type |
|---|---|
| Anderson (1990) | 2C, 5-6, EB, FP, FP-EB, EB-IX, IX |
| SORWT model (Hill et al. 1995) | 2C, 5-6, FP, IX |
| WSTRS (Agnew et al. 1996b) | 2C2, DW, P2, BY saltcake |
| HDW model (Agnew et al. 1996a) | 2C2, DW, P2, CSR |

Notes:

SORWT = sort on radioactive waste type

## D3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

An estimate of the bismuth phosphate waste discharged to the 241-B-110 cascade can be made from the tank farm process history and the reconstructed fuel processing history in Appendix B of Kupfer (1996). Table D3-4 summarizes this estimate.

Table D3-4. B Plant Fuel Processing and 2C Waste Disposition.

| Cascade | Period | Fuel Processed (MTU) |
|---|---|---|
| 241-B-110/241-B-111/241-B-112 | May 1945 to August 1946 | 631 |
| 241-B-104/241-B-105/241-B-106 | September 1946 to June 1950 | 1,312 |
| 241-B-110/241-B-111/241-B-112 | July 1950 to August 1952 | 823 |

An estimate of the amount of 2C waste discharged to each cascade can be made from the fuel process history and the flowsheet information in Appendix C of Kupfer (1996). The technical manual flowsheet is applied to the first time period and the Schneider (1951) flowsheet was applied to the last two time periods. The technical manual, issued in 1944, is considered representative of early B Plant operations, whereas the Schneider (1951) flowsheet is considered more representative of later years. Table D3-5 shows the results of this calculation.

Table D3-5. Disposition of B Plant 2C Waste.

| Period[1] | 5/45-8/46 | 9/46-6/50 | 7/50-8/52 | Total |
|---|---|---|---|---|
| Cascade | 241-B-110 | 241-B-104 | 241-B-110 | B Plant |
| Fuel processed (MTU) | 631 | 1,312 | 823 | 2,766 |
| Waste component (kg) | | | | |
| Bi | 8,990 | 23,900 | 15,000 | 47,900 |
| Cr | 421 | 1,190 | 748 | 2,360 |
| F | 19,900 | 54,100 | 33,900 | 108,000 |
| Fe | 8,610 | 31,000 | 19,400 | 59,000 |
| Na | 283,000 | 675,000 | 423,000 | 1,380,000 |
| $NO_3$ | 364,000 | 1,130,000 | 708,000 | 2,200,000 |
| Si | 4,970 | 13,100 | 8,200 | 26,300 |
| $PO_4$ | 235,000 | 423,000 | 265,000 | 923,000 |
| $SO_4$ | 29,500 | 107,000 | 66,800 | 203,000 |

Note:

Dates are provided in the mm/yy format.

Table D3-6 compares the calculated discharge of the 241-B-110 cascade to the sample-based inventory for tanks 241-B-110 and 241-B-111 is shown. Table D3-6 shows nearly equal accumulations of sludge in tanks 241-B-110 and 241-B-111. The waste transaction records state that both inventories are 2C waste. Overall a lack of agreement exists between the sample-based estimate for the tanks 241-B-110 and 241-B-111 versus the B Plant 2C waste projected to be discharged to the 241-B-110 cascade.

Table D3-7 compares the sample-based inventory, the HDW model inventory, and the flowsheet projected inventory. The best agreement for the species most likely to precipitate (Bi, Cr, Fe, and Si) is between the flowsheet based estimate and the sample-based estimate.

The sample-based data for tank 241-B-110 appears to account for the 2C waste discharged to the 241-B-110 cascade. This is the expected result for the first tank in a cascade. This result, however, is at odds with the large inventory of bismuth-bearing sludge found in tank 241-B-111.

Overall reconciliation of the 241-B-110, 241-B-11, and 241-B-112 cascade receipts to the sum of tank 241-B-110 and tank 241-B-111 is poor although the sludge in tanks 241-B-110 and 241-B-111 exhibit the characteristics of 2C waste. The waste is unlikely to be 1C waste because the Zr, Al, and Ce content is too low. The flowsheet evaluation projection accounts for approximately half of the 2C waste found in tanks 241-B-110 and 241-B-111 based on sample analysis. A possible explanation is that the throughput rate was twice the documented rate.

Table D3-6. Comparison of Tank 241-B-110 and Tank 241-B-111 Inventory Estimates to Total Cascade Receipts.

| Waste Component (kg) | Tank 241-B-110 Sample-Based Inventory Estimate (kg) | Tank 241-B-111 Sample-Based Inventory Estimate (kg) | Total Calculated Inventory Discharged to B-110, B-111, B-112 Cascade (kg) | HDW B-110, B-111, B-112 Cascade Retained (kg) |
|---|---|---|---|---|
| Bi | 23,200 | 21,500 | 24,000 | 21,000 |
| Cr | 1,014 | 1,180 | 1,170 | 792 |
| F | 2,370 | 1,660 | 53,800 | 4,400 |
| Fe | 22,600 | 18,900 | 28,000 | 89,600 |
| Na | 122,000 | 102,000 | 706,000 | 121,000 |
| $NO_3$ | 234,000 | 87,400 | 1,070,000 | 108,000 |
| Si | 11,700 | 11,100 | 13,200 | 6,660 |
| $PO_4$ | 61,600 | 51,800 | 500,000 | 69,000 |
| $SO_4$ | 14,400 | 12,400 | 96,300 | 7,930 |

Table D3-7. Comparison of Tank 241-B-111 Inventory Estimates to 241-B-110 Cascade Receipts.

| Waste Component (kg) | Sample-Based Inventory Estimate (kg) | HDW Model Inventory Estimate (kg) | Calculated Inventory Discharged to Cascade (kg) |
|---|---|---|---|
| Bi | 21,500 | 6,790 | 24,000 |
| Cr | 1,180 | 408 | 1,170 |
| F | 1,660 | 1,650 | 53,800 |
| Fe | 18.900 | 51,800 | 28,000 |
| Na | 102,000 | 31,800 | 706,000 |
| $NO_3$ | 87,400 | 32,700 | 1,070,000 |
| Si | 11,100 | 1,700 | 13,200 |
| $PO_4$ | 51,800 | 51,800 | 500,000 |
| $SO_4$ | 12,400 | 3,400 | 96,300 |

## D3.3 DOCUMENT ELEMENT BASIS

Bismuth, chromium, iron, silicon, phosphate, and sulfate in the flowsheet analysis are assumed to fully precipitate. The flowsheet analysis for the Bi, Cr, Fe, and Si agrees with the sample-based estimate; however, for the $PO_4$, and $SO_4$, the HDW model reconciles better with the sample-based estimate.

Fluoride, sodium, nitrate, and nitrite inventories can not be reconciled because these components are relatively soluble and would have exited the tank by the cascade system. The best source of information with respect to these compounds is the sample-based estimate.

Overall agreement of the sample-based inventories for the 241-B-110 cascade with the flowsheet projected inventory for the cascade is poor.

With respect to the sample-based inventory and the HDW-model inventory, several significant differences are apparent, for example, Al, Bi, Ca, Cl, Cr, Fe, Hg, K, Mn, Na, $NH_4$, Ni, $NO_2$, $NO_3$, Pb, $PO_4$, Si, S, U, and Zr vary by a factor of two or more.

## D4.0 ESTABLISH THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

The results from this evaluation are based on sampling data for tank 241-B-111 for the following reasons.

- Analytical results from two widely spaced core samples were used to estimate the component inventories. There is no reason to dispute the analytical results.
- Statistically, there was no horizontal stratification of the tank.
- Analytical results for the core samples are consistent with receipt of 2C waste.

These results are subject to future review because of the lack of reconciliation with the flowsheet projected inventory. Tables D4-1 and D4-2 show the best-basis inventory estimates for tank 241-B-111.

Table D4-1. Sample-Based Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-B-111 (September 30, 1996).

| Analyte | Total Inventory (kg) | Basis (S, M, or E)[1] | Comment RSD % |
|---|---|---|---|
| Al | 958 | S | 7 |
| Bi | 21,500 | S | 1 |
| Ca | 734 | S | 23 |
| Cl | 1,090 | S | 2 |
| TIC as $CO_3$ | 23,800 | S | 11 |
| Cr | 1,180 | S | 5 |
| F | 1,660 | S | 2 |
| Fe | 18,900 | S | 5 |
| Hg | 9.93 | S | 50 |
| K | 718 | S | 18 |
| La | 12 | S | 27 |
| Mn | 84.1 | S | 6 |
| Na | 102,000 | S | 2 |
| Ni | 22.1 | S | 7 |
| $NO_2$ | 47,900 | S | 9 |
| $NO_3$ | 87,400 | S | 8 |
| Pb | 1,670 | S | 7 |
| P as $PO_4$ | 51,800 | S | 8 |
| Si | 11,100 | S | 8 |
| S as $SO_4$ | 12,400 | S | 1 |
| Sr | 232 | S | 2 |
| TOC | 932 | S | 12 |
| $U_{TOTAL}$ | 210 | S | 4 |
| Zr | 15.3 | S | 29 |

Note:
[1]S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based

Table D4-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-111 (September 30, 1996). (2 sheets)

| Analyte | Total Inventory (Ci) | Basis (S, M, or E)[1] | Comment RSD % |
|---|---|---|---|
| $^{3}H$ | n/r | | |
| $^{14}C$ | 1.7 | S | 36 |
| $^{59}Ni$ | n/r | | |
| $^{60}Co$ | < 4.12 | S | |
| $^{63}Ni$ | n/r | | |
| $^{79}Se$ | n/r | | |
| $^{90}Sr$ | 264,000 | S | 22 |
| $^{90}Y$ | n/r | | |
| $^{93}Zr$ | n/r | | |
| $^{93m}Nb$ | n/r | | |
| $^{99}Tc$ | 121 | S | 10 |
| $^{106}Ru$ | n/r | | |
| $^{113m}Cd$ | n/r | | |
| $^{125}Sb$ | n/r | | |
| $^{126}Sn$ | n/r | | |
| $^{129}I$ | n/r | | |
| $^{134}Cs$ | n/r | | |
| $^{137}Cs$ | 168,000 | S | 9 |
| $^{137m}Ba$ | n/r | | |
| $^{151}Sm$ | n/r | | |
| $^{152}Eu$ | n/r | | |
| $^{154}Eu$ | 181 | S | 26 |
| $^{155}Eu$ | n/r | | |
| $^{226}Ra$ | n/r | | |
| $^{227}Ac$ | n/r | | |

Table D4-2. Sample-Based Best-Basis Inventory Estimate for Radioactive Components in Tank 241-B-111 (September 30, 1996). (2 sheets)

| Analyte | Total Inventory (Ci) | Basis (S, M, or E)[1] | Comment RSD % |
|---|---|---|---|
| $^{228}Ra$ | n/r | | |
| $^{229}Th$ | n/r | | |
| $^{231}Pa$ | n/r | | |
| $^{232}Th$ | n/r | | |
| $^{232}U$ | n/r | | |
| $^{233}U$ | n/r | | |
| $^{234}U$ | n/r | | |
| $^{235}U$ | n/r | | |
| $^{236}U$ | n/r | | |
| $^{237}Np$ | 0.0761 | S | 22 |
| $^{238}Pu$ | n/r | | |
| $^{238}U$ | n/r | | |
| $^{239/240}Pu$ | 104 | S | 5 |
| $^{241}Am$ | 90.1 | S | 25 |
| $^{241}Pu$ | n/r | | |
| $^{242}Cm$ | n/r | | |
| $^{242}Pu$ | n/r | | |
| $^{243}Am$ | n/r | | |
| $^{243/244}Cm$ | 0.501 | S | 57 |

Note:
[1]S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based

## D5.0 APPENDIX D REFERENCES


Agnew, S. F., J. Boyer, R. a. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, Draft, March 5, 1996, Los Alamos National Laboratory, Los Alamos, New Mexico.

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Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Giamberardini, K. K., 1993, *PNL 325 Laboratories Single-Shell Tank Waste Characterization, Tank B-111 Cores 29 and 30,* WHC-SD-WM-DP-041, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1996, *Tank Farm Surveillance and Waste Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

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Kupfer, M. J., 1996, *Interim Report: Best Basis Total Chemical and Radionuclide Inventories in Hanford Site Tank Waste*, WHC-SD-WM-TI-740, Rev. E-Draft, Westinghouse Hanford Company, Richland, Washington.

Schneider, K. J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, Hanford Atomic Products Operation, Richland, Washington.

# APPENDIX E

# BIBLIOGRAPHY FOR TANK 241-B-111

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# APPENDIX E

## BIBLIOGRAPHY FOR TANK 241-B-111

Appendix E is a bibliography that supports the characterization of tank 241-B-111. This bibliography represents an in-depth literature search of all information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-B-111 and its respective waste types.

The references in this bibliography are separated into three broad categories containing references which have been broken down into subgroups.

### I. NONANALYTICAL DATA

- Ia. Models/Waste Type Inventories/Campaign Information
- Ib. Fill History/Waste Transfer Records
- Ic. Surveillance/Tank Configuration
- Id. Sample Planning/Tank Prioritization
- Ie. Data Quality Objectives/Customers of Characterization Data

### II. ANALYTICAL DATA

- IIa. Sampling of Tank 241-B-111 Waste
- IIb. Sampling and Analysis of Similar Waste Types

### III. COMBINED ANALYTICAL/NONANALYTICAL DATA

- IIIa. Inventories from both Campaign and Analytical Information
- IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

This bibliography is broken down into appropriate sections of material with an annotation at the end of each reference describing the information source. Where possible, a reference is provided for information sources. A majority of this information can be found in the Lockheed Martin Hanford Corporation Tank Characterization Resource Center.

# I. NONANALYTICAL DATA

## Ia. Models/Waste Type Inventories/Campaign Information

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, 1990, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign and waste type information up to 1981.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

- Sorts tanks into groups by waste type.

Jungfleisch, F. M., B. C. Simpson, 1993, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*, WHC-SD-WM-TI-057, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- A model based on process knowledge and radioactive decay estimations using ORIGEN for different compositions of process waste streams assembled for total, solution, and solids compositions per tank. Provides assumptions about waste and waste types and solubility parameters and constraints.

Schneider, K. J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, Hanford Atomic Products Operation, Richland, Washington.

- Contains compositions of process stream waste before transfer to 200 Area waste tanks.

## Ib. Fill History/Waste Transfer Records

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L Young, 1996, *Waste Status and Transaction Record Summary for the Northeast Quadrant*, WHC-SD-WM-TI-615, Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains spreadsheets showing available data on tank additions and transfers for the northeast quadrant.

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign and waste type information up to 1981.

**Ic. Surveillance/Tank Configuration**

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-RE-TI-053, Rev. 9, Westinghouse Hanford Company, Richland, Washington.

- Shows tank riser locations in relation to tank aerial view and a description of risers and associated equipment.

Dasgupta, A., 1995, *Interim Stabilization Status of SSTs B-104, B-110, B-111, T-102, T-112, and U-110*, WHC-SD-WM-ER-516, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains the results of investigation to determine whether six single-shell tanks continue to meet interim stabilization criteria. It concluded tanks 241-B-111, 241-B-110, and 241-U-110 meet the criteria.

Hanlon, B. M., 1996, *Tank Farm Surveillance and Waste Status Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

- Most recent release of a series of summaries including fill volumes, Watch List tanks, occurrences, integrity information, equipment readings, equipment status, tank location, and other miscellaneous tank information. The series includes monthly summaries from December 1947 to present; however, Hanlon has only compiled the monthly summaries from November 1989 to present.

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- Provides a ready reference to the tank farms safety envelope.

Lipnicki, J., 1996, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Assesses riser locations for each tank; however, not all tanks are included/completed. Includes an estimate of risers available for sampling.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Compiles information on thermocouples and the status for Hanford Site waste tanks.

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Welty, R. K., *Waste Storage Tank Status and Leak Detection Criteria, Volumes I and II,* WHC-SD-TI-356, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Describes the nature, scope, and frequency of surveillance used for waste storage tanks, states action criteria for response to data deviations, and presents tank data reviews between June 15, 1973, and June 15, 1988.

**Id. Sample Planning/Tank Prioritization**

Borsheim, G. L., and D. J. Larkin, 1971, *Evaporator Feed Samples*, (internal memorandum to L. W. Roddy, October 7), Atlantic Richfield Hanford Company, Richland, Washington.

- Describes sampling and analysis requirements of the stored evaporator feeds.

Brown, T. M., J. W. Hunt, and T. J. Kunthara, 1996, *Tank Waste Characterization Basis*, WHC-SD-WM-TA-164, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Summarizes the technical basis for characterizing waste in tanks and assigns a priority number to each tank.

Hill, J. G., W. I. Winters, L. Jensen, B. C. Simpson, J. W. Buck, P. J. Chamberlain, and V. L. Hunter, 1991, *Waste Characterization Plan for the Hanford Site Single-Shell Tanks*, WHC-EP-0210, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

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Kupfer, M. J., M. D. LeClair, W. W. Schultz, and L. W. Shelton, 1995, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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**Ie. Data Quality Objectives/Customers of Characterization Data**


Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Determines whether tanks are within safe operating conditions.


## II. ANALYTICAL DATA

**IIa. Sampling of Tank Waste and Waste Types**


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- Contains sample analyses from 1991 core sampling event.

Heasler, P. G., C. M. Anderson, D. B. Baird, R. J. Serne, and P. D. Whitney, 1993, *Statistical Evaluation of Core Samples from Hanford Tank B-111*, PNL-8745, Pacific Northwest Laboratory, Richland, Washington.

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Remund, K. M., J. M. Tingey, P. G. Heasler, J. J. Toth, F. M. Ryan, S. A. Hartley, D. B. Simpson, and B. C. Simpson, 1994, *Tank Characterization Report for Single-Shell Tank B-111*, PNL-10099, Pacific Northwest Laboratory.

- Original tank characterization report based on 1991 core sampling event.

**IIb. Sampling and Analysis of Similar Waste Types**

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- Discusses analyses of 1989 and 1990 sampling events and analysis of tank 241-B-110, which contains 2C and P2 wastes.

## III. COMBINED ANALYTICAL/NONANALYTICAL DATA

**IIIa. Inventories from Campaign and Analytical Information**

Agnew, S. F., J. Boyer, R. Corbin, T. Duran, J. FitzPatrick, K. Jurgensen, T. Ortiz, and B. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

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- Contains summary information from the supporting documents for Tank Farms A, AX, B, BX, BY, and C, and in-tank photo collages and the solid (including the interstitial liquid) composite inventory estimates.

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Shelton, L. W., 1996, *Chemical and Radionuclide Inventory for Single- and Double-Shell Tanks*, (internal memorandum 74420-96-30 to D. J. Washenfelder, February 28), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

**IIIb. Compendium of Existing Physical and Chemical Documented Data Sources**

Brevick, C. H., L. A. Gaddis, and W. W. Pickett, 1995, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 Areas*, WHC-SD-WM-ER-349, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Contains summary information from the supporting documents for Tank Farms A, AX, B, BX, BY, and C, and in-tank photo montages and the solid (including the interstitial liquid) composite inventory estimates.

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- Contains a quick reference to sampling information in spreadsheet or graphical form for 23 chemicals and 11 radionuclides for all tanks.

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- Contains tank farm description, tank historical summary, level history and surveillance graphs, in-tank photographs, and waste inventory information.

DeLorenzo, D. S., J. H. Rutherford, D. J. Smith, D. B. Hiller, K. W. Johnson, and B. C. Simpson, 1994, *Tank Characterization Reference Guide*, WHC-SD-WM-TI-648, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Summarizes issues surrounding characterization of nuclear wastes stored in Hanford Site waste tanks.

Hartley, S. A., G. Chen, C. A. Lopresti, T. A. Ferryman, A. M. Liebetrau, K. M. Remund, and S. A. Allen, 1996, *A Comparison of Historical Tank Contents Estimates (HTCE) Model Rev. 3, and Sample-Based Estimate*, PNNL-11429, Pacific Northwest National Laboratory, Richland, Washington.

- Compares historical data to sample-based estimates.

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- Contains in-tank photos and summaries on the tank description, leak detection system, and tank status.

Husa, E. I., 1995, *Hanford Waste Tank Preliminary Dryness Evaluation*, WHC-SD-WM-TI-703, Rev. 0., Westinghouse Hanford Company, Richland, Washington.

- Assesses relative dryness between tanks.

Remund, K. M., and B. C. Simpson, 1996, *Hanford Waste Tank Grouping Study*, PNNL-11433, Pacific Northwest National Laboratory, Richland, Washington.

- Document is a multi-variate statistical study categorizing tanks into groups based on analytical data.

Van Vleet, R. J., 1993, *Radionuclide and Chemical Inventories for the Single Shell Tanks*, WHC-SD-WM-TI-565, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains selected sample analysis tables prior to 1993 for single-shell tanks.

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